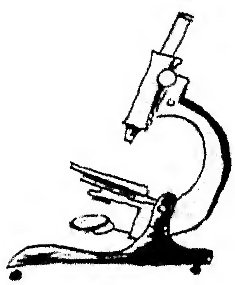
A Unified Program in
Science, Health, and Safety

Senior responsibility for the series . . . .



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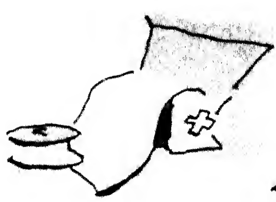
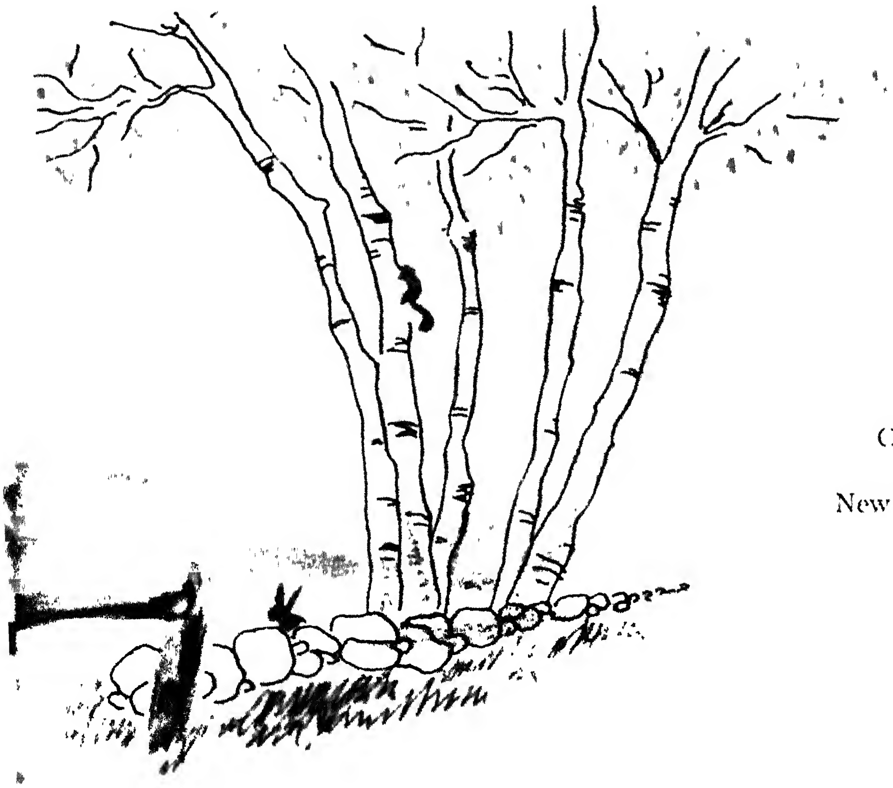


THE MACMILLAN SCIENCE



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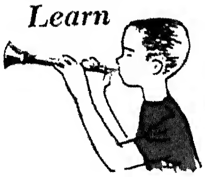

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Managing Wildlife

Illustrated by Hertha Depper

Technical drawings by Felix Traugott, Leonard Derwinski, and Graphic Presentation Services

1 *Comparing Things*

About *"Comparing Things"*

Ever since you were a small child, you have been asking questions to find out things. Maybe you have asked questions like these:

Why shouldn't children drink coffee?

Do people live on other planets?

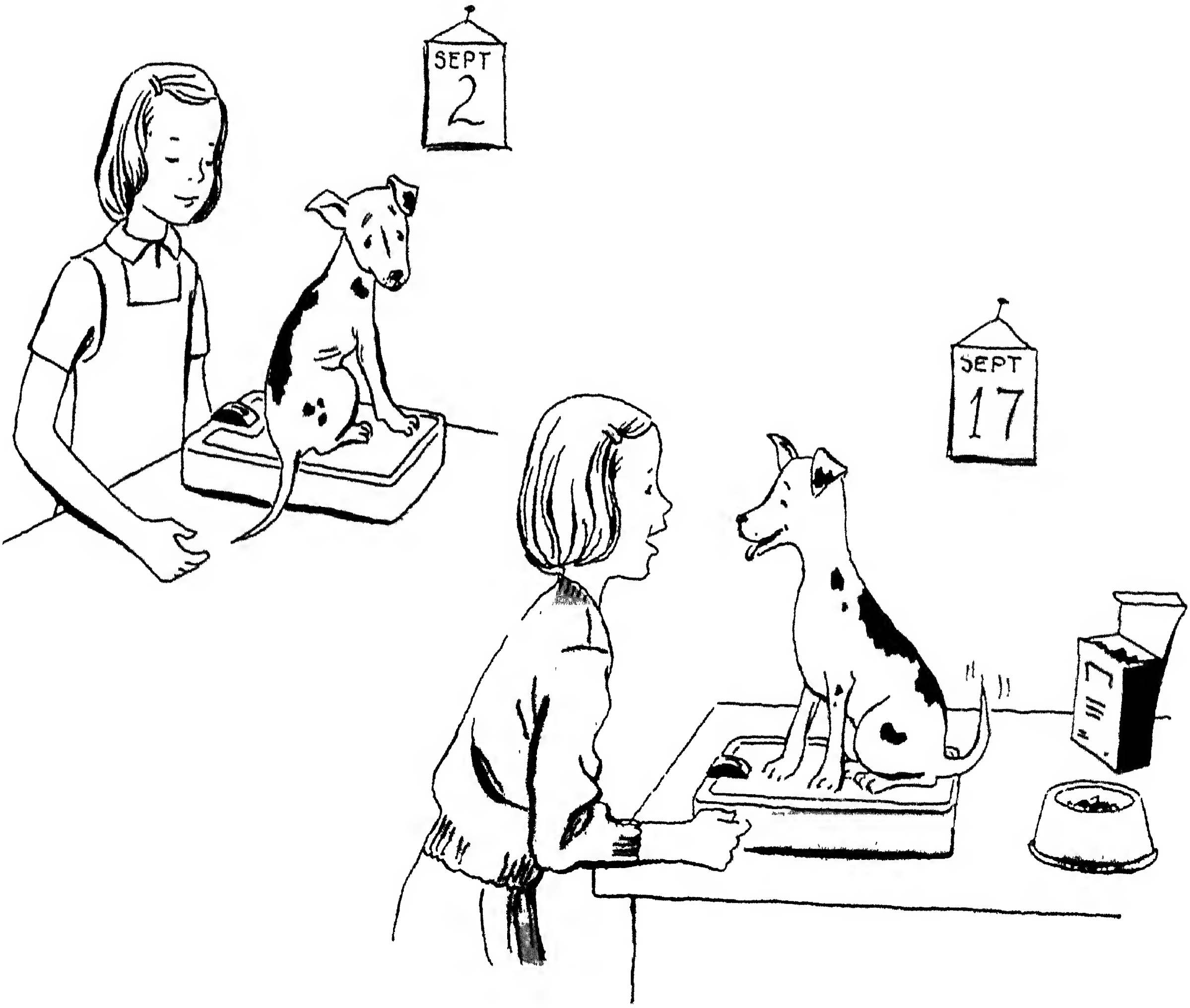
Why is it so hard to see a jet plane in the sky if you look in the direction of the noise?

You can find answers to such questions in several ways. You can look in a book, ask a grownup, or write for information.

But suppose you wanted to find out which bicycle *you* liked better, an English racer or an American bike with balloon tires. Would asking someone help you find the answer? Would looking in a book?

To find out which bicycle you liked better, you would have to try out both kinds. You would **compare** them. Comparing things is the only way to find answers to many questions.

Scientists, too, find many of their answers by comparing things. But scientists have special ways of comparing things. In this book you will read about some special ways scientists compare things.



DIFFERENT KINDS OF COMPARISONS

Suppose you want to find out which paint is better for keeping your bicycle from rusting. You might paint the front fender with one paint and the back fender with another. Then you treat both fenders the same. You let it rain on both. You let the sun shine on both. Or you try to protect both. Whatever you do to one, you do to the other, too. You are comparing two different things at the same time.

There is another kind of comparison. We call this other kind a before-and-after comparison. Suppose your dog has been losing weight lately and doesn't seem playful. So you decide to give him another kind of food.

First, you observe your dog's weight and health *before* you start giving him the new food. Then you observe his weight and health *after* he has eaten the food for a week or more.

Can you think of a comparison to make where you use two different things? Can you think of a before-and-after comparison to make?

How Scientists Make Comparisons

Doctors know that a great many diseases are caused by germs. Some of these germs are tiny animals. Some are tiny plants, called bacteria. Still others are viruses. All of these germs are so small that we can see them only with a microscope. Viruses are the smallest of all. They can be seen only through a very powerful microscope. The lenses in a microscope make things look many times bigger than they are.

Doctors and scientists have worked for a long time to find drugs that would kill germs without hurting the patient. In the last 20 years they have found many new drugs like penicillin, streptomycin, and aureomycin. In all of their work, the scientists have used comparisons.

It has been known for a long time that certain germs are killed when put into the soil. If garbage is left in the open air, many kinds of disease germs grow in it. But if the garbage is buried in the ground, the germs do not grow. Some scientists wondered why.

Dr. Selman Waksman, a great American scientist, wondered if something that was growing in the soil might kill the germs. To test his idea, Dr. Waksman made many comparisons.

He studied soils from different parts of the country. In some of these soils he found tiny plants that he thought might be useful. He tried them one at a time and compared the results.

First, he put disease germs into special covered dishes. These dishes contained food that would help the germs grow and increase in number. Into one dish full of germs he put one kind of tiny plant from the soil. Into another dish he put another kind of plant from the soil. He kept other dishes of germs aside, putting nothing into them. After a while he was ready to make comparisons.

He put a dish of disease germs without plants in it alongside each dish to which plants had been added. Then he compared the growth of the germs. Most of the time, he found that there was no difference. But once in a great while, he found that the germs had stopped growing in a dish to which he had added a particular kind of tiny plant.

But how could he be sure that the plants had caused the germs to stop growing? Maybe they had stopped for some other reason.

Now Dr. Waksman was ready for another kind of comparison. Into new dishes of germs he put the same kind of plant that had stopped the germs before. In dish after dish the germs stopped growing. It must have been the tiny plants that stopped them.

Dr. Waksman made many other comparisons. He tried different amounts

Chas. Pfizer & Co.

Institute of Microbiology, Rutgers

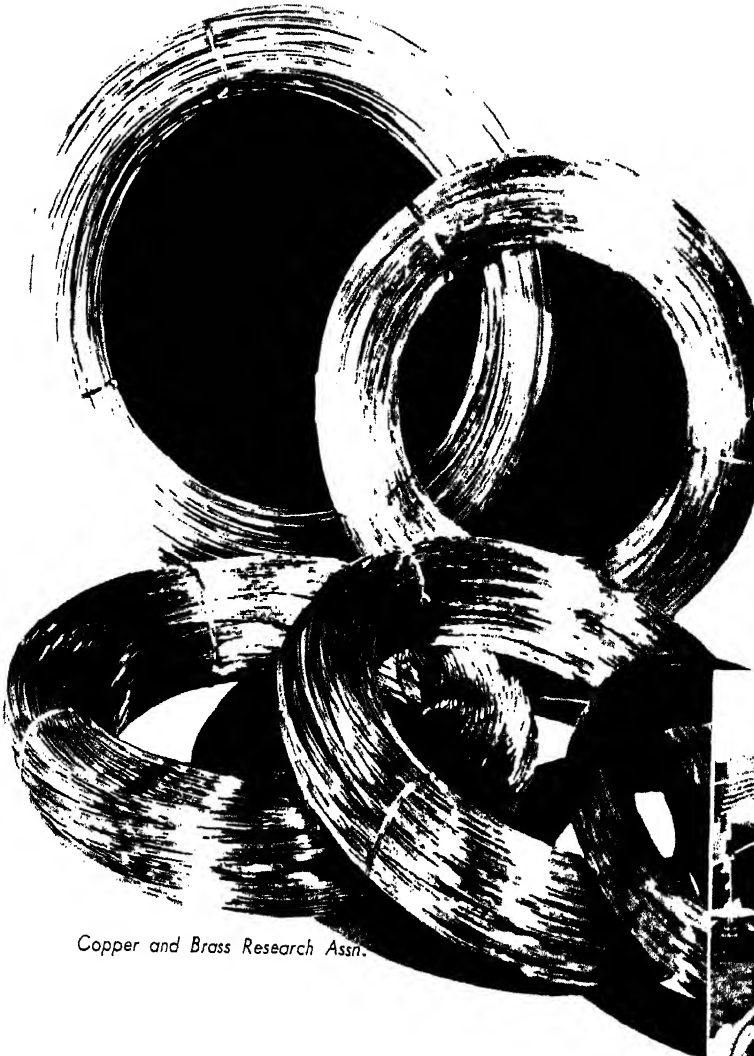
Dr. Selman Waksman. His work with tiny plants from the soil has helped doctors fight disease. In experiments, the tiny plants are grown in flat, round dishes called petri dishes.

of the plants to see how many were needed. He tried the plants on many different kinds of germs. He found that the plants stopped the growth of some germs but let other germs keep on growing.

Scientists nearly always need to make comparisons when they test a new idea. Suppose a scientist wants to find out if a new kind of metal makes stronger wire than the kinds of wire we already have. He would have some wire made of the new kind of metal. He would have it made of a certain thickness. Then he would see how much weight the wire would hold before it broke. He would compare this weight with the weight other wires of the same thickness held.

We make comparisons when we buy things. When you go with your mother to buy clothes, you want to find the best quality for the least money. You compare prices and you compare quality of material.

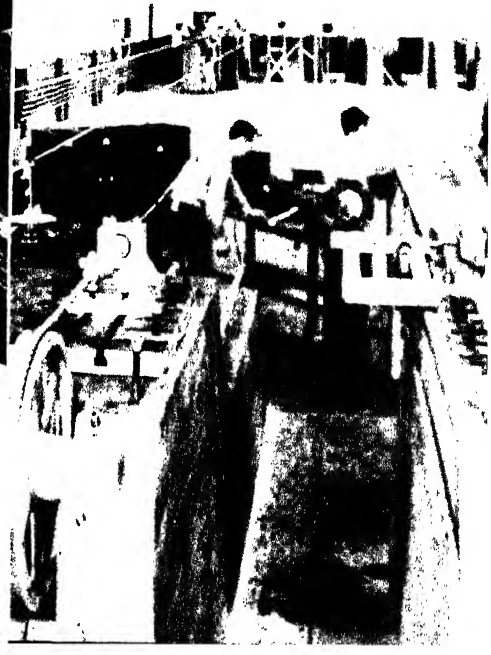
When you buy a fountain pen, you want to find one that is comfortable to write with. You try out different pens and compare them until you find the one that suits you. There are many times when a comparison is the best way to find the answer to a question.



Copper and Brass Research Assn.

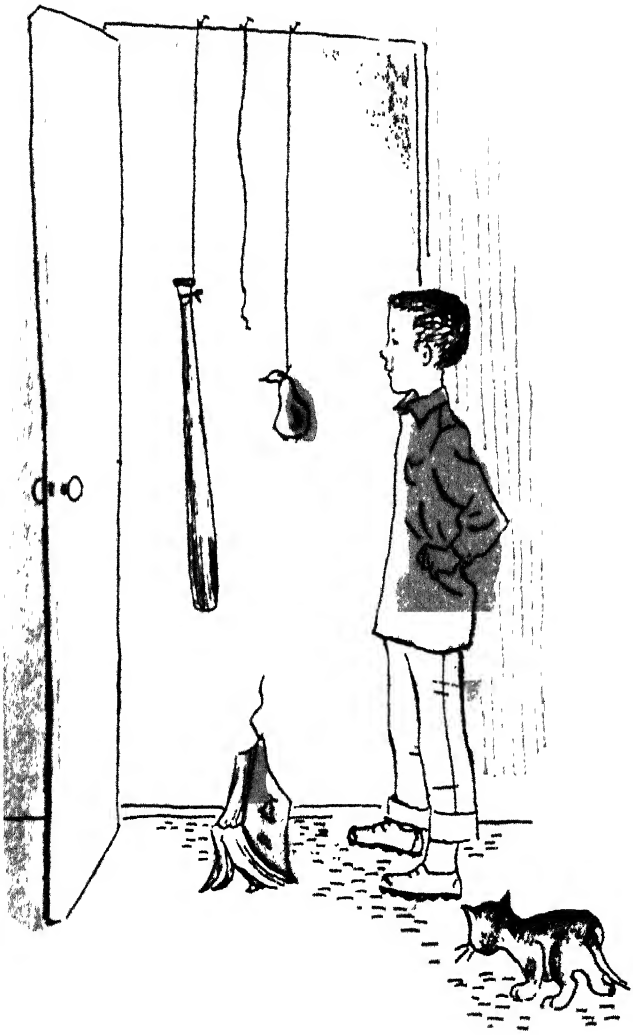
Wire must be strong enough to do its particular job. Manufacturers have special testing machines, but you can test the strength of wire or string at home.

Alu[illegible]



WHAT IS AN EXPERIMENT?

Scientists don't start out by looking for things to compare. They start with a question, or problem. For example, Dr. Waksman wanted to find out whether certain tiny plants keep germs from growing. When scientists have a problem, they decide what things they can compare to help them solve it. They also plan the best way to make the comparisons.



Suppose you wanted to find out what color clothing can be seen most easily on boys and girls riding bicycles at night. This is a question you can answer by comparing colors at night.

Perhaps you would think back to the times you were out at night and try to remember which colors you saw most easily. Is this a good way? Do you think a scientist would use this way?

There is another way to go about making your comparison. You could very carefully plan the comparison before you made it. You could ask yourself questions like these:

What colors should I compare?

Where should I compare them?

How many comparisons should I make?

How can I make sure that each color is tested under the same conditions?

Once I find the answer, how can I use it?

When you plan a comparison this way, you are doing more than just trying something out. You are doing an **experiment.** In scientific work, the planning is a very important part of an experiment. The job of some people in science is just planning experiments that other people do.

How Scientists Plan Experiments

First, a scientist must know the purpose of his experiment—what he is trying to find out. Suppose a scientist is given the problem of finding out if some new kind of cloth will last longer than cotton or wool. He doesn't care whether most people think the new kind of cloth is pretty. He doesn't care if it costs more than cotton or wool cloth. He wants to find out only if it will last longer.

How should the scientist plan his experiment? Could he make a good comparison by testing a single thread from one cloth and a single thread from another? Could he ask people to wear clothing made of each kind of cloth to see how well each kind wears? Why would it be better to put each cloth on a machine that tests its strength?

He must be sure, too, that he tests each piece of cloth under the same conditions. The testing machine must be the same for both. The temperature of the room must be the same. What other conditions must be kept the same?

But not all experiments are done to find the answer to a new question. Suppose you had read that white is easier to see at night than any other color. You might say to yourself, "Even though I have read that white is easier to see, I want to make sure." Then you do an experiment to test this answer.

Whatever the reason for doing an experiment, the important things to remember are these:

1. An experiment begins with a question to be answered or an idea to be tested. You must know what you are trying to find out.
2. An experiment is carefully planned.
3. In an experiment you know what things you must keep the same as you make your comparisons.

Below: A comparison. One paint has stood up well. The other, under the same conditions, has not. *Right:* Manufacturers do experiments to see how well new fabrics wash. Can you plan an experiment to see how different fabrics wash?

A Famous Experiment

Great scientists not only help discover new knowledge for us. They also help us see how experiments should be done. We can study their ways of working to improve our ways of experimenting.

Louis Pasteur was a great French scientist who lived about a hundred years ago. At that time, many cattle, sheep, and other farm animals were dying of a disease called **anthrax.** Pasteur thought about the problem and wondered if anthrax could be prevented by shots.

This way of preventing disease is not new to you. You have probably had shots since you were a baby. These shots have kept you from having diseases, such as smallpox, that used to take many lives.

But in Pasteur's time, the idea of shots was a new one. Only one kind of shot, the one for smallpox, had been used before. Pasteur had the idea that he could make anthrax shots from bacteria taken from sheep that had anthrax. He thought that if the animals got small doses of weak bacteria over a period of time, they would not die of the disease.

Now came the famous experiment. On a farm outside a little French town 48 sheep, cows, and goats were divided into two pens. The animals in one pen were given anthrax shots over a period of time. The animals in the other pen were not given the shots. Then, about a month later, the animals in both pens were injected with enough live bacteria to kill them. Scientists gathered to watch what would happen. In a few days, all but two of the animals who had not had shots were dead. Not a single animal who had had the shots was sick!

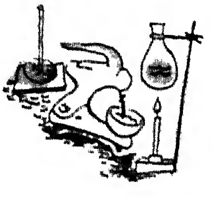
Other scientists now accepted Pasteur's idea. When there is enough evidence to prove a new idea, a scientist must be ready to give up his old idea and accept the new one.

Now let's see how Pasteur worked.

1. He started with a problem: Could sheep be protected from anthrax by shots?
2. He planned the experiment carefully. He divided the animals into two groups and gave the anthrax shots to one group but not to the other.
3. He kept some things the same for both groups. Animals in both groups were healthy to begin with, and each received the same kind of care, except for *one* thing. The shots were given to only half the animals.
4. He had enough animals to prove he was right. Scientists must be sure to have enough evidence to prove a point. Testing only a few animals did not convince other scientists of Pasteur's discovery. The experiments had to be repeated with enough animals to prove that he was right.

Can you use these same ways of working as you plan and carry out experiments?

Things to Do



How good are you at comparing things? Plan an experiment to solve each of the following problems. Perhaps you can try one of the experiments you plan.

a. Will a plastic raincoat keep me drier than a cloth raincoat?

b. Will a round-bottom model boat tip more easily than a flat-bottom model boat?

c. Does it take less time to bake a potato when it is wrapped in aluminum foil?

Culver

Pasteur tested his idea. He gave anthrax shots to sheep. Then he injected enough bacteria into the same sheep to kill them. The sheep lived. Getting the shots over a period of time kept them from getting the disease.

Other scientists, however, did not believe Pasteur. They did not think that anthrax could be prevented by a shot. Scientists want to have enough evidence to prove an idea.

Left: Louis Pasteur in his laboratory. *Below:* Because of Pasteur's work this cow need never die of anthrax. The shot she is getting will protect her.

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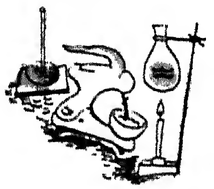

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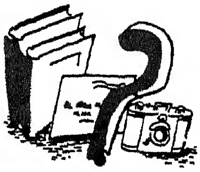
In making your plan, you will want to think about these things.

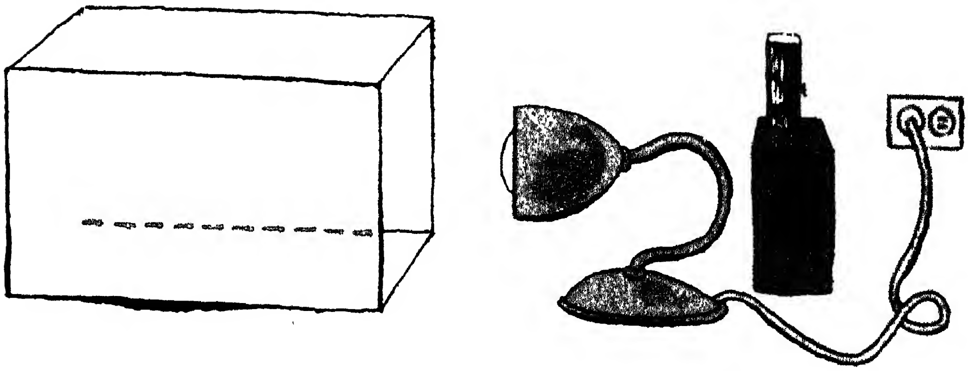
What am I going to compare?
What will I measure?
How will I measure?
What things will I keep the same?
What materials will I need?
How many times must I repeat the comparison?

If You Want to Find Out More



What color is best for the walls in your classroom? Brown? White? Green? Yellow? Which do *you* like best? Which one reflects the most light? You can do an experiment to compare how well these different colors reflect light. You will need a light meter for this experiment. Light meters are used in taking pictures. Perhaps you can borrow one from a friend.

Get a box like the one in the picture and cover the inside with colored paper. Put an electric lamp in front of the box. Hold the light meter at the other side so that only the light reflected from the colored paper hits it. The more light the paper reflects, the higher the number shown on the meter will be. Now try paper of some other color. Read the meter again. Compare the different colors of paper that you have selected. What did you find out?



2 The Science of Food

About *"The Science of Food"*

Bobby Rice had just finished eating a Pig's Dinner at a drive-in restaurant. Proudly he wore a large button. "I was a pig at the Dog-and-Shake Drive-In" was printed on it. Everyone wanted to know what a Pig's Dinner is and what the button was for. "A Pig's Dinner," said Bobby, "has four scoops of ice cream, bananas, pineapple, chocolate syrup, cherries, nuts, marshmallow, and whipped cream! If you can eat it all, you get a button like this one."

Perhaps you are asking what a Pig's Dinner has to do with the science of food. Actually, science has a good deal to do with what Bobby ate and how he ate it. Because of scientific discoveries, we have answers to problems such as these:

What nutrients are there in foods?
How can we make foods safe to eat?
How can we serve foods without spreading germs?
What will foods do for you?

FOOD FOR GROWING

Think for a moment of all the things you do in a single day. Perhaps you spend some of the day working on a stamp collection or making model airplanes. Some boys and girls your age give lots of time and energy to different clubs. Maybe you like to spend your time on a big job, such as building a boat. Most boys and girls take part in many activities. You need energy to carry on all these activities. This energy comes from the food you eat every day.

You are also growing every day. You started growing before you were born. Even when you have become as tall as you will ever get, parts of you will still be growing. New skin will gradually grow to replace the skin that wears away. Your hair and nails will keep growing. And all things that grow need food.

How Tall Can You Grow?

If your parents are tall, you will probably be tall. If your parents are short, you *may* grow to be taller than they are, but probably not much. In order to grow as tall as it is possible for *you* to grow, you must have enough of the right kind of food.

How can we be sure that proper eating helps you grow taller? One way to find answers to such a question is to make scientific comparisons. How tall are a group of children who eat plenty of good food? How tall are a group of children who do not get as much good food? Is this a helpful comparison? Of course, we would have to find out if both groups of children have parents of about the same size. Why? Would such a comparison tell if food is important for growing?

Scientists have made such a comparison. They measured the height of two groups of nine-year-old children in the United States. The parents of both groups were about the same size. But one group of children had always had good food. The other group had always had poor food. The scientists found that the group with the good diet was, on the average, 51 inches tall. The group with the poor diet averaged 48 inches.

Some other scientists measured a group of French children after World War II. During the war, eggs, meat, and other foods were hard to get. The scientists found that young children who had grown up in Paris during this time were smaller than children had been before the war. They believe this difference was caused by the poor diet during the war.

The Nutrients

Perhaps you think of diet only in connection with fat people. Some children think that the word *diet* means eating less food to lose weight. But the food scientist uses this word to talk about all the foods that a person eats.

What do you think would happen to a person who ate only lemon sherbet? Lemon sherbet for breakfast, lemon sherbet for lunch, lemon sherbet for dinner—with lemon sherbet for dessert. Well, lemon sherbet may taste good, but this poor fellow would not stay healthy very long.

To have a good diet means to eat enough of all the different kinds of foods your body needs. It means eating enough of the substances you need in order to grow and keep healthy. These important substances in food are called **nutrients.** Some of them that you know are vitamins, sugar, starch, fats, and water. But there are others, and you need all of them to keep healthy.

Scientists haven't found any single

food that has every one of the different nutrients. A boy who eats only peanut butter will be getting some important nutrients. But there will be many nutrients missing from his diet.

One way to make sure you get the nutrients you need is to eat different kinds of foods. How many different kinds of foods do you eat? Try this. Keep a record of all the foods you eat for two days. You will find that, like most people, you eat some foods very often. But there are many foods that you hardly ever eat.

Look around the vegetable store or the grocery store the next time you shop. Make a list of the foods you have never tasted. Compare your list with a friend's. Do most people you know like the same foods?

There is much to choose from in today's markets. It is up to you to choose wisely.

Supermarket Merchandising

Here are the nutrients your body needs. Next to each nutrient is an explanation of what it does for you and a list of some foods which contain it.

Nutrients	*Some Things They Do*	*Some Foods Containing Them*
Protein	Builds the body. Repairs worn body parts.	**Eggs, meat, milk, fish and other sea food, cheese, poultry, peas, beans, peanuts.**
Vitamins	Keep the body working properly. Help prevent certain diseases. Help keep eyes, skin, and gums in good condition.	**Liver, fruit, vegetables, eggs, milk, lean meat, fish.**
Minerals	Help build bones and teeth. Needed for the blood to deliver oxygen to the cells of the body.	**Milk, liver, dried fruit, shellfish, vegetables.**
Fats	Furnish energy. Protect the body.	**Fat meat, butter, milk, oleomargarine and salad oils, eggs, nuts.**
Carbohydrates	Furnish energy.	**Cereals, bread, candy, sugar, potatoes.**
Water	Makes up most of the body.	**Drinking water, almost all foods.**

The Four Food Groups

An easy way to make sure you get all the nutrients is to use the four food groups as a guide. The most common foods have been divided into four large groups by food scientists. If you were grouping foods, there are many kinds of groups you could make. You might put together all the foods with chocolate in them. Or you might put together all the kinds of foods you eat for breakfast. Or you might put together foods having the same nutrients.

The food scientist does it a different way. He thinks about the jobs your body has to do. He puts together as a group the foods that help the body do a special job. One simple plan divides foods into four groups: the milk group, the meat group, the vegetable-fruit group, and the bread-cereals group.

The chart on the next two pages is arranged according to this plan. Notice that the chart doesn't list the nutrients. Instead, it shows four different groups of foods which contain these nutrients.

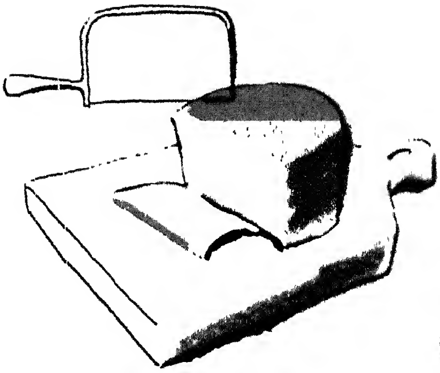
Try this. Check your own meals with the four food groups. Are you eating foods from each of the groups every day? Notice that the number of servings from each group is important, too. It isn't necessary to have a food from each group at each meal. But you should have enough food from each group every day.

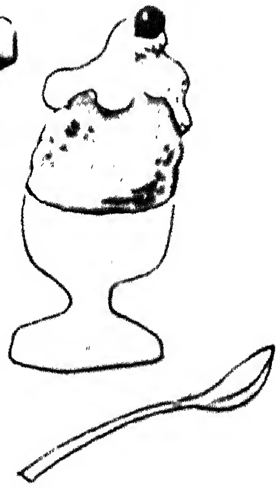
You will notice that fats and sugar are not shown at all. The experts who made the plan felt that most people get enough fat when they put butter on bread or eat foods prepared with cooking oils. The experts felt the people get enough sugar in jelly, cake, and other sweet foods.

But remember that people are different. Some people need more food than other people. Ballplayers usually need more food than typists. Big people usually need more food than small people. Adults usually need more food than very young children. Even two adults the same size, weight, and age may need different amounts of food. The food groups chart tells you what kinds of foods to eat every day. It doesn't tell you how much *you* should eat.

The chart doesn't tell you that you have to eat just certain foods, either. If you don't like lamb, for example, you may eat hamburger, or chicken, and still have a good diet. If lobster is too expensive, you can eat eggs, or cod, or haddock. Strawberries make some people's skin turn red and itchy. Those people are **allergic** to strawberries. They can eat cherries, pears, or any one of many other fruits or vegetables instead. Two people can eat completely different foods and each one get all the nutrients he needs for growth and good health.

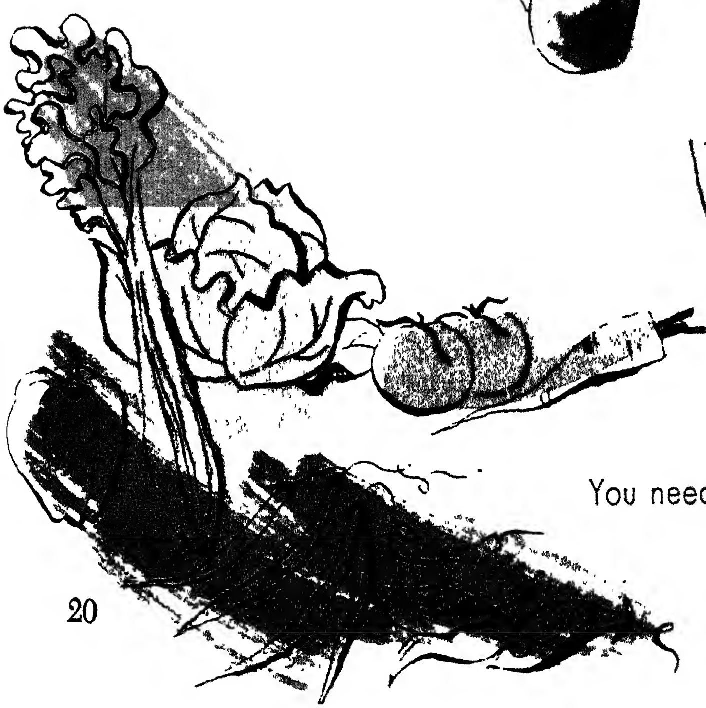
THE FOUR FOOD GROUPS





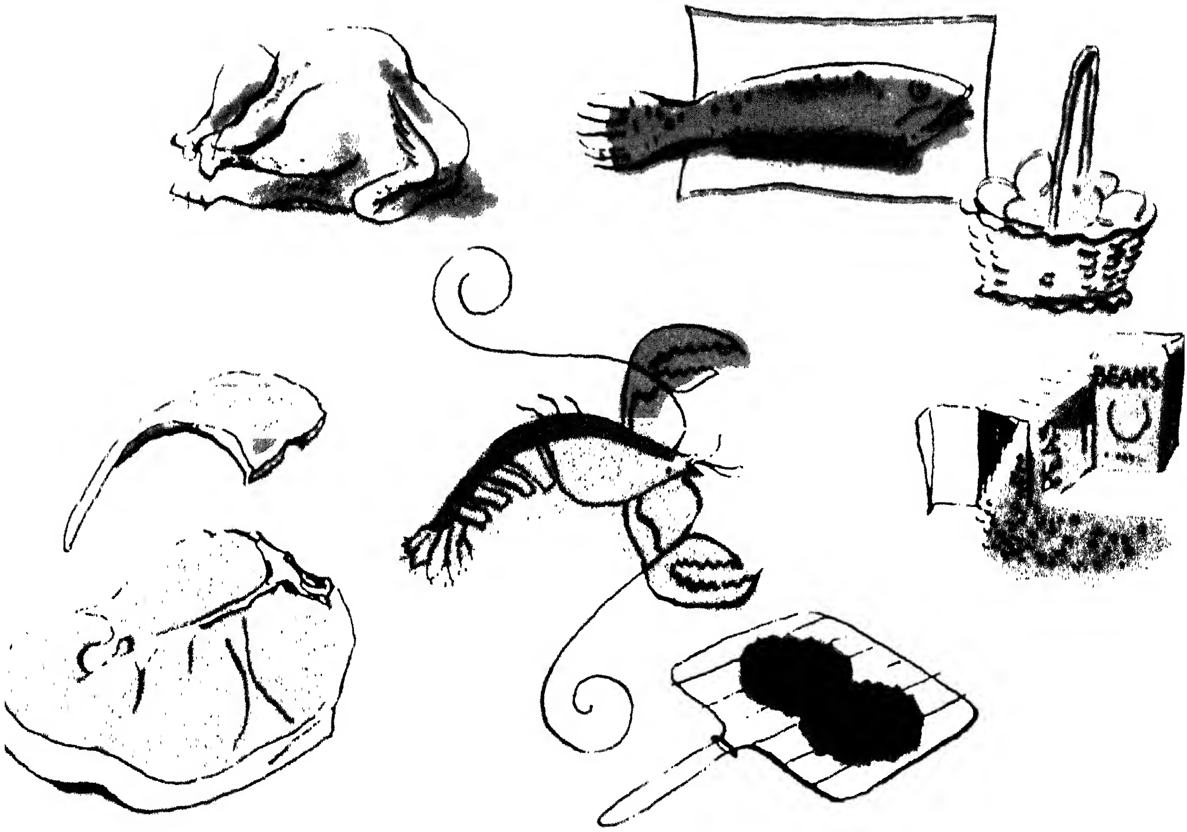
MILK GROUP

You need 3 to 4 cups of milk a day.



VEGETABLE-FRUIT GROUP

You need 4 or more servings a day.

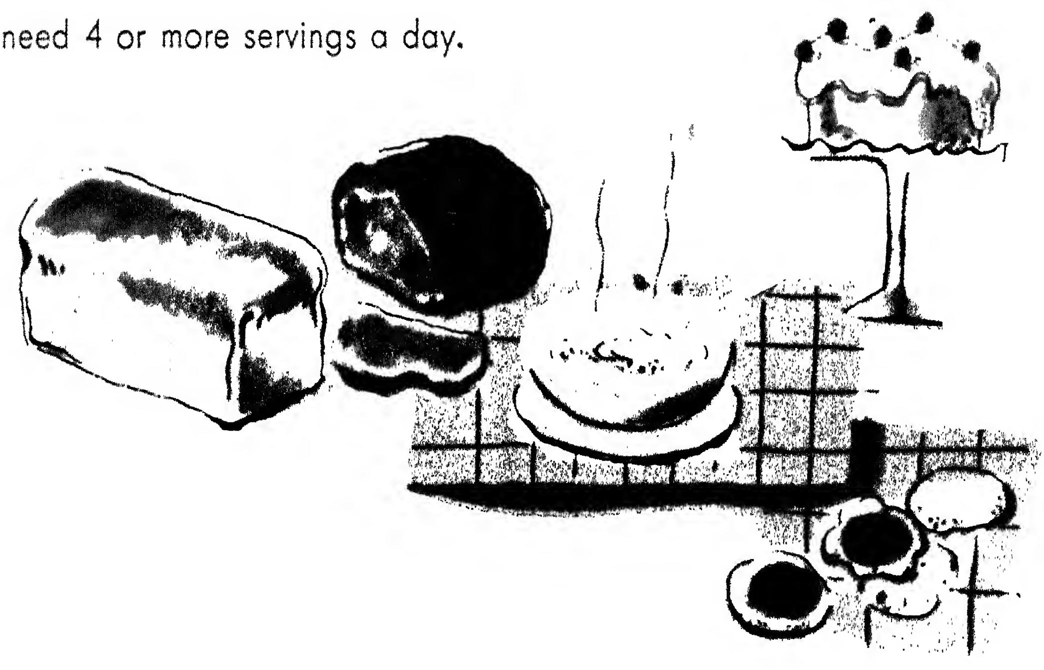


MEAT GROUP

You need 2 or more servings a day.

BREAD - CEREALS GROUP

You need 4 or more servings a day.

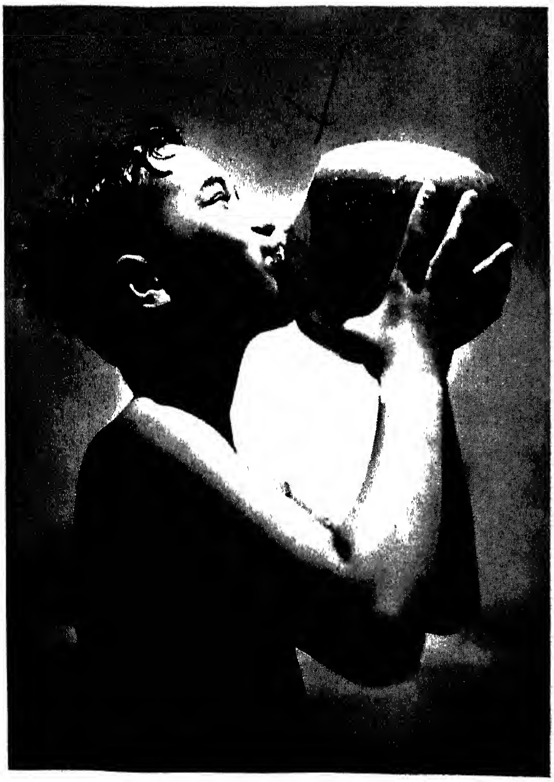


Ewing Galloway

An Eskimo family at mealtime

A Hawaiian boy finds a drink of coconut milk refreshing.

Hawaii Visitors Bureau



Foods in Other Countries

Look at the four food groups on pages 20–21 again. Do you think this chart would help the Eskimos? Do Eskimos bake bread, or raise chickens? Do they grow carrots or green beans or cabbage?

Our government food scientists worked out the four food groups to help people in the United States plan meals that have all the nutrients. That is why you find only foods generally eaten in this country on the chart. The chart could also be used in European countries where the foods eaten are similar to ours. But an Eskimo gets his nutrients from other foods. Bird or reindeer or seal meat gives the Eskimo some of his essential nutrients. The Eskimo may be just as healthy as you if he gets all the nutrients.

Boys and girls all over the world

Japan Tourist Association

Rice and fish are the principal foods of Japan.

need the same nutrients. They are all human beings with the same physical needs. But they do not all get these nutrients from the same foods. The four food groups would look entirely different in different parts of the world.

Here is an example of what the four food groups would look like in another part of the world. Boys and girls in Turkey have learned to like many foods different from those you like. A four-food-groups plan for them would look like this:

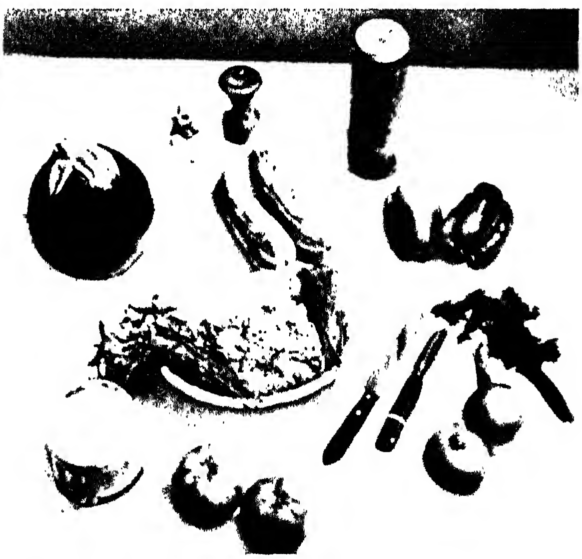
Milk Group—Yogurt, a kind of soured milk.

Meat Group—Lamb, chicken, peas, beans.

Fruit-Vegetable Group — Eggplant, peppers, zucchini, tomatoes, okra, figs, dates.

Bread-Cereals Group—Cracked wheat, rice.

Turkish people use lamb, rice, and vegetables to prepare their favorite dishes.



Turkish Information Office

Protein

A very important substance in the food you eat is the nutrient protein. Your heart, skin, muscles, and almost every part of you contains protein. You are nearly two-thirds water. And almost all the rest of you that isn't fat is protein. Is it any surprise that you need lots of protein in your diet?

You will find foods that are rich in protein in the milk group and in the meat group on pages 20–21.

In the United States meat is a common source of protein. Americans eat more of it every year. But there are different kinds of protein, and meat does not contain all the kinds. We can also get necessary protein from fish, eggs, milk, cheese, and the vegetables shown on the chart. Kidney beans are a good source of protein. Baked beans, pea soup, and other dishes made with dried peas and beans are good sources of protein too.

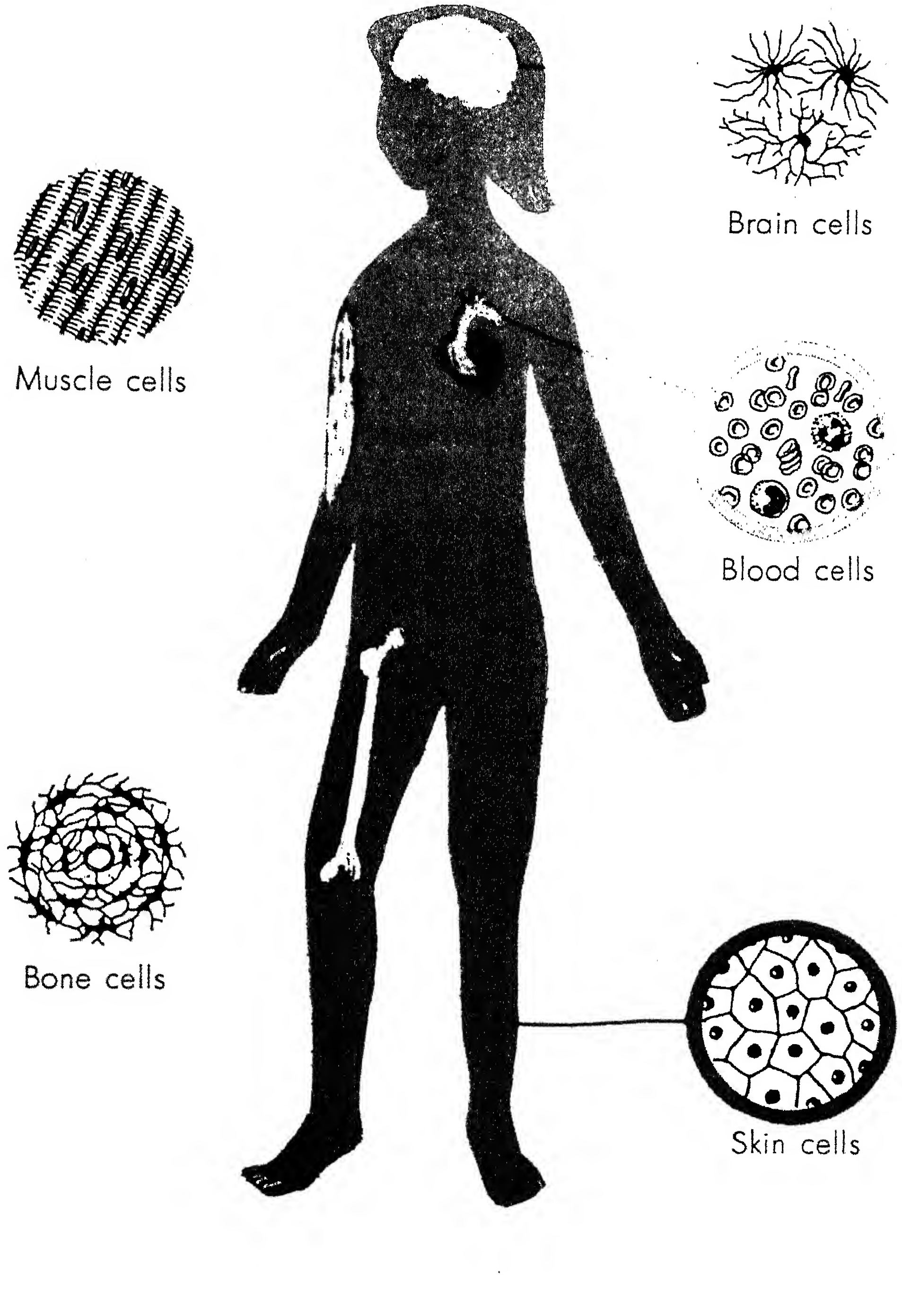
In some countries the people are not able to get enough different kinds of protein for good health. Meat, milk, cheese, and eggs are too scarce and too expensive to eat regularly. The people may have to get most of their protein from corn, peas, and beans.

But it is hard to supply the body with as many different kinds of protein as it needs from plant foods alone. Scientists are trying to find ways of adding other inexpensive protein foods to the diet. One scientist wanted to see what could be done to improve the Mexican diet. He discovered that a kind of flour can be made from dried fish. This flour is rich in protein and would not cost much. If this new flour can be added to their diet, many Mexican people will be able to eat more kinds of protein.

Protein does many things for the body. You may know that there are millions of tiny structures in your body called **cells**. Your skin, your eyes, your heart—all of you—is made of tiny cells. The cells are too small to be seen without a microscope.

Every day your body grows thousands of new cells. Cells are added to your skin, to your bones, and to your blood. When you say you are growing, you are really saying that you are getting thousands of new cells. And each cell is made partly of protein. Does this help you understand why doctors say that growing children should eat more protein foods than adults?

There is still another reason why we need protein. Every day, certain cells in your body wear away. Skin cells are worn off every time you pick up a pencil. Your blood cells are being worn away every second. New cells are always being made to replace the worn ones. What nutrient does your body need for this building job?


Brain cells
Muscle cells
Blood cells
Bone cells
Skin cells

Things to Do

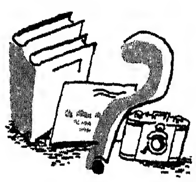
1. Plan a menu for a cook-out. Include foods from each of the four food groups. Write after each item which food groups it represents.

2. The people of Denmark are famous for their open sandwiches. One restaurant in Copenhagen serves over 175 different kinds. The menu is four feet long. The Danes arrange on a thick slice of bread meats, cheeses, fish, vegetables, or even fruits. For example, on dark oatmeal bread there might be some thinly sliced ham and cheese on half the slice, with lettuce, sardine, and sliced tomato on the other half.

What interesting sandwich combinations can you put together? Try some at home and report to the class on your most successful efforts. How many food groups are there in each sandwich?

3. Make a class cookbook, using the recipes that you made up in doing the activities above. You can add new recipes from time to time through the year.

If You Want to Find Out More



1. There are many advertisements that tell you what foods to buy. Some advertisements say that you should eat a certain cereal because some famous person eats it. Other advertisements tell you to eat a certain food because it gives you pep.

You can check some of these advertising statements. Study the labels on six cereals. On each package you will see a list of nutrients to be found in that cereal. Do the products differ in the nutrients they contain?

2. Dried peas and beans are very cheap protein foods. See if you can find a cookbook which lists the amount of protein in different foods. How much protein is there in a cupful of baked beans? How much does a cupful of baked beans weigh? How much protein would there be in the same weight of sirloin steak? How much would each cost?

Protein is necessary for building your body. But protein alone is not enough. You know that you need all the other nutrients every day, too. You need large amounts of some of the nutrients. You need only tiny amounts of others. Some of the ones that are needed only in small amounts are called minerals. They are found in many of the foods you eat. Three very important minerals that you will read about are iodine, iron, and calcium.

Iodine

You need iodine to help control how quickly your body uses up energy. A person who does not get the proper amount of iodine may get a disease called **goiter.** Goiter is a swelling of a gland in the neck. It used to be very common in some sections of the country. You need iodine in only very small amounts, but you need it regularly to stay healthy.

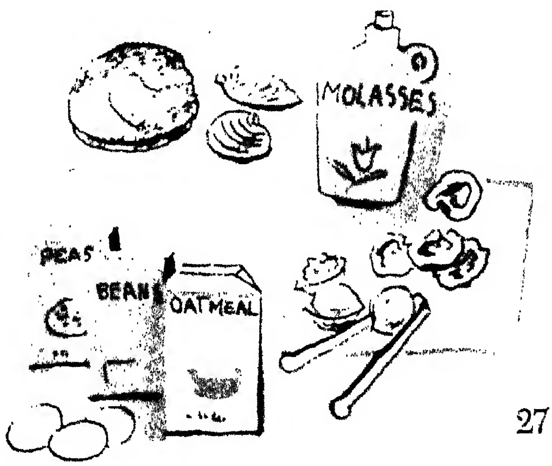
This important mineral nutrient, iodine, is found in the sea. It is also found on land that was once under the sea. Ocean fish, lobsters, clams, oysters, and other sea food contain iodine. Before frozen fish became popular, some people who lived far from the sea often found it hard to get sea food. They sometimes did not get enough iodine.

To help prevent goiter, companies that sell table salt usually add small amounts of iodine to the salt. The package says, "iodized salt." Iodized salt will furnish all the iodine you need if you use it regularly. Look at the box of salt you have at home to see if the salt is iodized.

Iron

Iron is another necessary mineral. It is needed in your blood. Your blood carries oxygen to every cell in your body. You remember that oxygen is the part of the air that goes into our blood through the lungs. Only tiny amounts of iron are needed to help the blood carry oxygen. But not getting enough iron sometimes causes an illness called **anemia.** People with anemia get tired easily because their blood is not carrying as much oxygen as it should.

Some foods rich in iron are shown below.

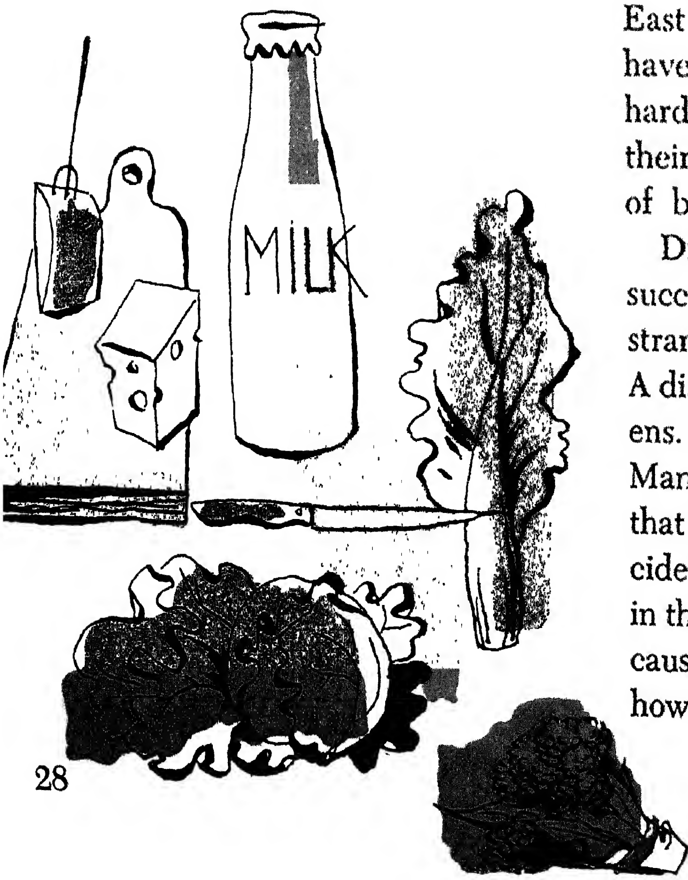


Calcium

More calcium is needed in your body than any other mineral. Your teeth and bones are made hard partly by the mineral calcium. Your blood and muscles also need small amounts.

Of the foods that you usually eat, milk is the best one for calcium. In fact, it is hard to get enough calcium without drinking milk or eating things that are made from milk. Ice cream is one food made from milk. Try making a list of as many other foods as you can think of that are also made with milk. Do you eat many of these foods?

Some of the green, leafy vegetables are next best for calcium. Kale, turnip tops, and broccoli contain this important mineral.



Vitamins

In the early 1900's, scientists thought that fats, proteins, minerals, water, and carbohydrates were the only nutrients. They tried feeding some animals pure protein, pure minerals, pure carbohydrates, and water, but the animals did not stay healthy. They got diseases that they did not get very often when they ate natural foods. The scientists decided that natural foods must contain tiny amounts of some substance they didn't know about. What could it be?

At about this time a Dutch doctor named Eijkman was studying diseases in the East Indies. He was trying to find a cure for a disease called beriberi. Every year many people in the East Indies got beriberi. People who have it get tired and dizzy. They can hardly move around. And they lose their appetite. Sometimes people die of beriberi.

Dr. Eijkman was not having much success. Then one day something strange happened near his laboratory. A disease broke out among some chickens. The chickens could hardly move. Many died. Dr. Eijkman discovered that the chickens had beriberi. He decided to try to find out what caused it in the chickens. Perhaps the same thing caused it in human beings. Let's see how he solved the problem.

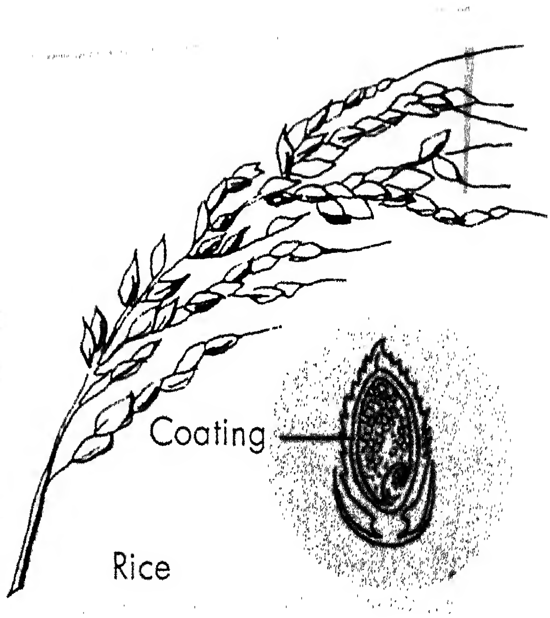
First, he separated the sick chickens from the healthy ones. But the healthy chickens got beriberi anyhow. This experiment, along with some others, showed Dr. Eijkman that beriberi was not contagious. That is, you don't get it just from being with a sick person, as you do many diseases.

After Dr. Eijkman had been experimenting with the chickens for about five months, the chickens suddenly got well! And no more beriberi broke out!

Dr. Eijkman was puzzled by this. He wondered if something about the chickens' food caused the disease. He decided to find out what they had been eating. He soon discovered an unusual fact. Ordinarily, the chickens were fed whole, complete rice grains. But during the months that they had beriberi, they had been fed polished rice from the hospital kitchen. Polished rice has the brown coating on the outside removed.

Maybe this change in the chickens' food had something to do with beriberi. Dr. Eijkman guessed something in the coating of the rice prevented beriberi. He wanted to test his guess scientifically. What would you have done to test this guess?

Dr. Eijkman decided to experiment some more with the chickens. He separated some of them into two groups. He gave one group polished rice. He gave the other unpolished rice.



The chickens that ate the polished rice soon got beriberi. The others stayed healthy. Then Dr. Eijkman gave the sick chickens rice with the coat on. They got well. Because of his careful comparisons, Dr. Eijkman decided that beriberi is caused by a lack of some unknown nutrient found in rice coats. People who ate polished rice were not getting this nutrient, whatever it was. He had made an important discovery.

Later on, a scientist from Poland, who was working in England, removed some of this nutrient from rice coats. Today we call it **thiamine.** It is also found in the coats of wheat, oats, and other grain.

Thiamine is one of the vitamins. It is one of a number of vitamins that we call the B group vitamins. Two other vitamins in this group are **riboflavin** and **niacin.**

You need riboflavin in order to grow. It helps your body use protein properly. You also need it to see well. Niacin helps to prevent a disease called pellagra. People who have pellagra have reddened, sore skin and are very nervous.

Different vitamins help our bodies in different ways. This vitamin chart tells where some of the vitamins are found and what they do.

Note that the four food groups on pages 20-21 were planned to include these foods. A good choice from the four food groups gives you all the vitamins you need. If you have a good diet, you do not have to take special vitamin pills unless a doctor recommends them. Remember, too, that a good diet may contain many nutrients that are not found in vitamin pills. And a good diet may even give you certain vitamins that scientists do not know about yet.

Where Some Vitamins Are Found and What They Do

Vitamin	*Where It Is Found*	***What It Does***
A	Carrots, sweet potatoes, dandelion greens, spinach, kale, broccoli, turnip greens, liver, egg yolk, butter, milk, cheese.	**Important for building the body. Maintains healthy skin and eyes.**
B GROUP	Peas, beans, liver, enriched bread, fish, poultry, milk, eggs, kale, turnip greens, avocados, broccoli, cauliflower, cabbage, okra.	**Keeps nervous system and skin healthy. Helps growth. Lack of B vitamins causes beriberi and pellagra.**
C	Oranges, lemons, grapefruit, tangerines, pineapple, tomato, cauliflower, raw cabbage, green pepper, turnip greens.	**Maintains good mouth and gum health. Keeps blood vessels strong.**
D	Fish liver oils, vitamin D milk. (Sunshine helps your body make its own vitamin D.)	**Needed for proper bone formation.**

Deficiency Diseases

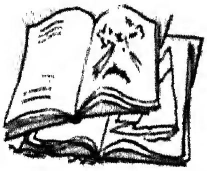
Dr. Eijkman's work and the work of other scientists have helped us to know something very important about disease. They have helped us to see that some diseases are caused when the body doesn't get certain nutrients. We call these diseases **deficiency diseases.** Can you see why this is a good name for such diseases?

The idea that you can get a disease if you don't eat certain foods probably doesn't seem very new or exciting to you. Your mother has probably been telling you for years that you would get sick if you didn't "eat right." But the idea of deficiency diseases is a bigger idea. This idea is that there is a direct connection between not eating a certain nutrient and getting a certain disease—but only that disease. If a person doesn't have thiamine in his diet, he'll get beriberi—not pellagra. If he doesn't have vitamin C, he'll get scurvy —not beriberi.

Can you see how this discovery helps us? Because of it we know that we must have certain nutrients in our diet. And because of it, doctors know what to do for a patient who has the signs of one of the deficiency diseases.

Few people in this country die from deficiency diseases. You probably have never known anyone with beriberi or scurvy, fortunately! But although we may not be lacking enough of a nutrient to get a disease, we may not be as healthy as we should be, either. Children get bleeding gums if they don't have enough vitamin C. And children learn better when they are getting enough of the B group. Vitamins and minerals do certain things for our bodies. If we don't get enough of each one, there will be some sign of the lack.

Things to Read About



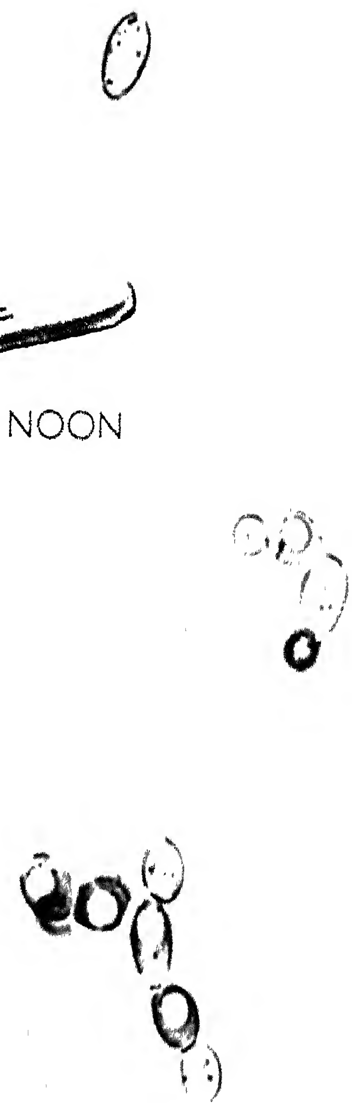
1. Dr. Joseph Goldberger discovered that the real cause of pellagra was a lack of niacin. Find out, if you can, about the experiments he did with prisoners to discover this fact. You might look up his name, or the word *pellagra*, in an encyclopedia.

2. English sailors are often called "limeys." The story of how they got this name is really a story about vitamin C. See if you can find out how the name "limey" got started. Look up the words *scurvy* and *vitamin C* for help.

10 AM

12 NOON

2 PM



Fleischmann Laboratories Standard Brands

Yeast cells, enlarged 1000 times. They multiply very quickly. Yeasts are often useful to man. For example, it is yeast that makes bread rise.

Tiny plants cause most of the spoiling of foods. Sometimes they make food unsafe to eat. Many of these plants are so small they cannot be seen without a microscope, yet they are always floating in the air. Three common kinds of these tiny plants are molds, yeasts, and bacteria.

Molds, yeasts, and bacteria, like all other plants, need certain things to grow. In earlier grades you found that certain plants need water, air, soil, warmth, and light. How can you find out what molds, yeasts, and bacteria need?

Growing Mold

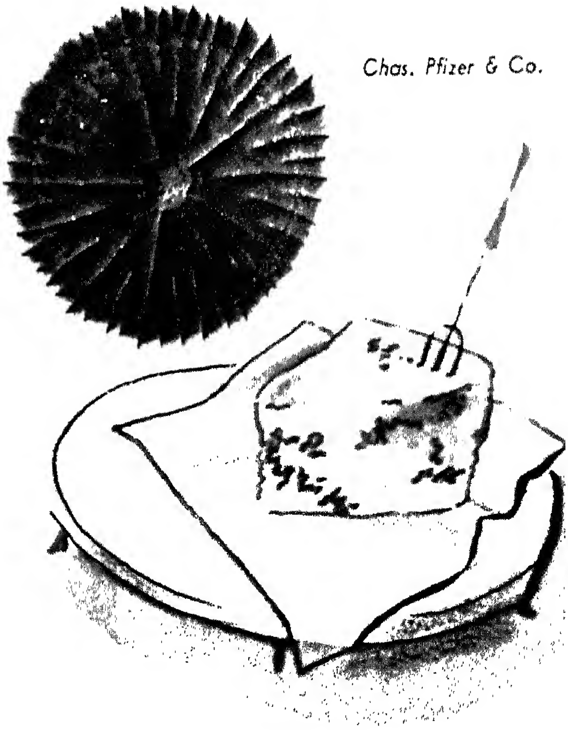
Some of the common molds are bigger than yeast and bacteria. You can see them without a microscope. Mold can grow on almost any food. You have probably seen mold on stale bread, but have you ever tried to grow mold? All you do is let some moist bread stand in the air for several days. Some mold will settle on the bread and grow. The mold uses the bread as food. It cannot make its own food, as green plants can.

Does mold need water to grow? See for yourself. Put a piece of dry bread in a dish. Put another piece of bread from the same loaf on a moist blotter in another dish. Keep the blotter moist for several days. Which piece of bread has more mold on it?

This experiment should give you a hint of one way to stop mold from forming on food—one way to stop food from spoiling. Molds, like yeast and bacteria are living things. All living things need water. That is why more mold grows on the wet bread.

Let's find out more about mold. You remember that green plants need sunlight to grow. What experiment can you do to see if mold needs sunlight to grow? You can put one dish of moist bread into a dark closet. Put another dish of moist bread in the sun. Then compare the mold in the two dishes.

If you can use a refrigerator at school



Chas. Pfizer & Co.

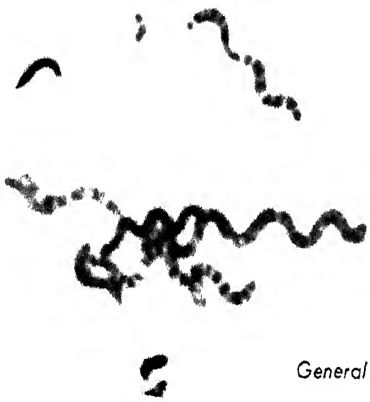
Some molds are useful. The colony of mold above produces the drug penicillin. A similar mold is used to make Roquefort-type cheeses.

or at home, plan an experiment to find out if mold needs warmth to grow. How many pieces of bread will you need? Where will you put them? How can you see that each piece gets the same amount of moisture? How can you see that each is kept in the dark? Will you expect as much mold to grow on the bread in the refrigerator?

Some molds are very useful to man. Certain kinds of molds are used in making cheeses. The mold is grown separately and then is added to the cheese while it is being aged. The tiny plants Waksman worked with were something like molds only smaller.

Chas. Pfizer & Co.

Round bacteria, enlarged 3,000 times



General Biological Supply Co.

Spiral, enlarged about 2,300 times

Chas. Pfizer & Co.

Rod-shaped, enlarged 2,500 times

These are the main types of bacteria.

Bacteria in Food

Food that has become moldy often smells bad. It may taste even worse. We don't like to eat it for those reasons. But a little mold on food won't make us sick.

Even food with some kinds of bacteria in it won't make us sick. In fact, some bacteria are very useful to the food industry. Bacteria help in the making of cheese. They help in changing fruit juice to vinegar. Sometimes you may see mold on the surface of the vinegar. You know that mold and bacteria are not the same.

Disease Germs

But some kinds of bacteria are harmful. They cause certain kinds of diseases. We use the word **germs** for the tiny living things that cause disease. Some kinds of bacteria are germs. If these harmful bacteria get into our bodies, we may get sick.

Germs are not the only cause of diseases, as you know. You have already read about deficiency diseases. Later you will read about other causes of disease.

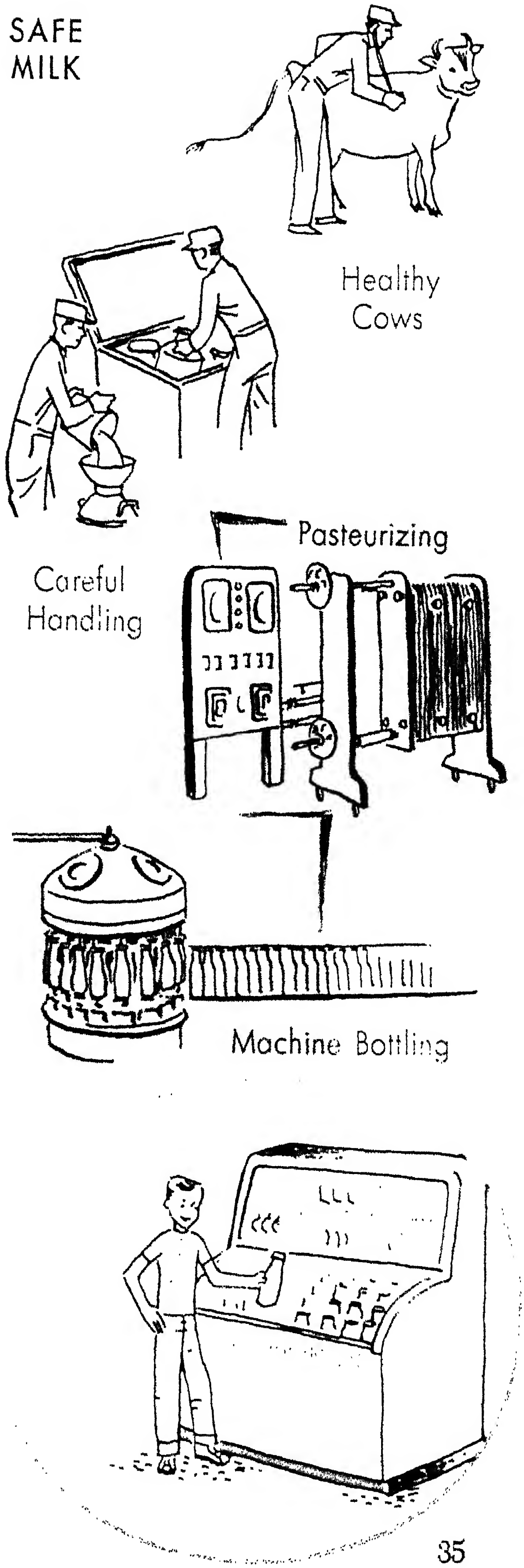
Man hasn't always known that germs cause disease. For centuries it was believed that evil spirits entering the body caused the illness. To be cured, the sick person had to have the evil spirit driven out. Sometimes medicine men tried to scare the spirit away by chants. Sometimes the sick person was put into a steam bath to sweat out the spirit. But too often the person died.

From the work of several great scientists we know that germs can cause disease. But germs can harm us only when they get into our bodies. One way they can enter is in the food that we eat.

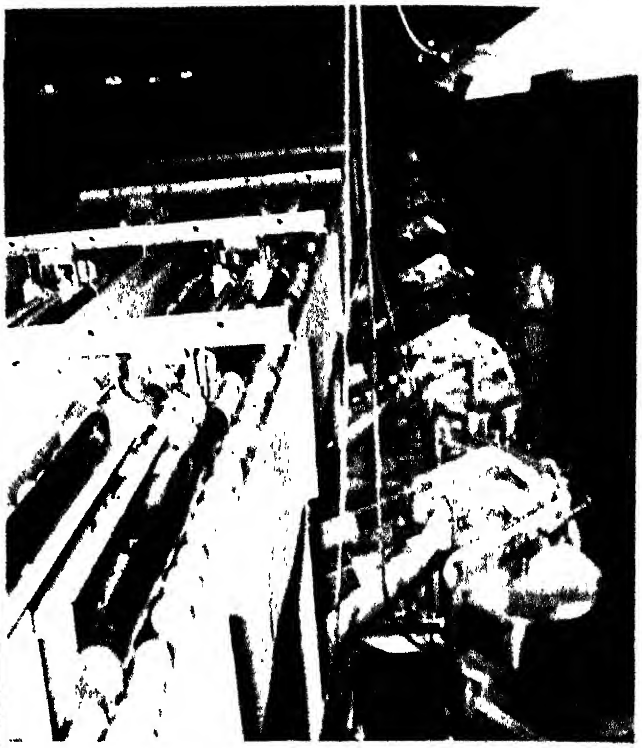
This isn't a very pleasant thought, is it? We wouldn't enjoy that chocolate ice-cream sundae nearly as much if we thought we were eating disease germs along with it.

Fortunately, we know a great deal about how to make foods safe. After scientists learned that disease germs in the body can make us sick, they looked for ways to keep out the germs. One way is to kill them before they enter our bodies.

We don't need to worry about that chocolate ice-cream sundae. There are some disease germs that *can* live in milk and cream. These germs cause diseases like typhoid fever and tuberculosis. But, in most parts of this country, milk is very carefully safeguarded. In many states, cows are inspected regularly to make sure they do not have a disease. Also, most of us drink **pasteurized** milk. This is milk that has been heated to about 145° to kill dangerous germs.



Right: Machines sorting oranges and removing the juice. The juice will then be frozen. As long as it is kept frozen, germs cannot grow in it. *Below:* Smoking will keep these hams safe to eat for a long time. The heat dries the hams, while the smoke destroys many germs.



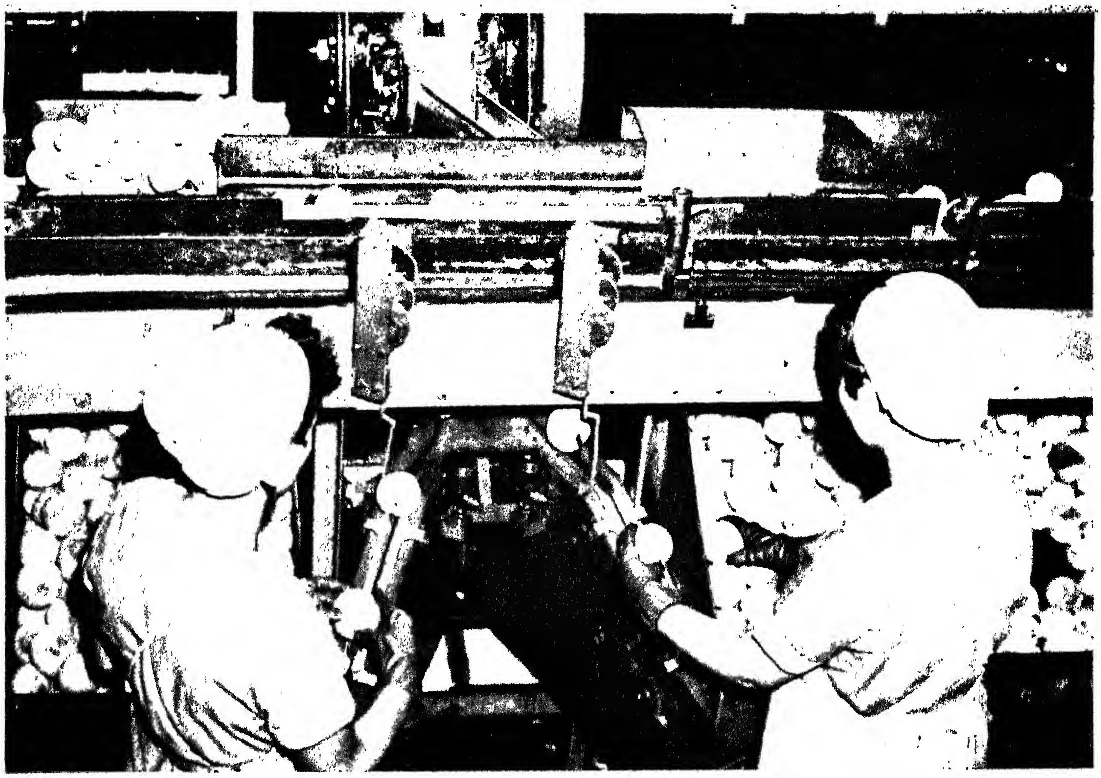
American Meat Institute

Killing disease germs by heat is one way to make sure food is safe for use. When foods are canned in factories, they are heated to kill disease germs. When your mother cooks foods at home, any disease germs in it are destroyed.

But there are other ways to make food safe for eating. Can you tell what they are? Remember, disease germs are living things. All living things need certain conditions to grow.

All living things need a suitable temperature. How can you keep foods safe for us to eat by changing the temperature?

All living things need moisture. How can you keep foods safe if you know



Photos, National Canners Association

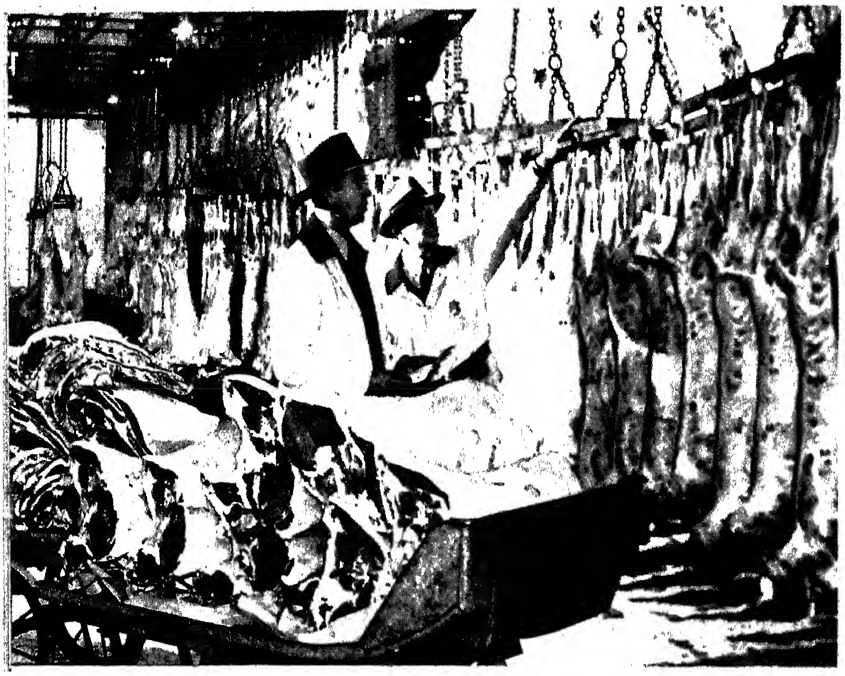
disease germs need moisture to grow? In what different ways are foods treated to drive out moisture from them? How are some foods packed in order to keep out moisture?

All living things need food. In what different ways do we keep germs from getting into food?

All living things need oxygen, too. You and some other living things get oxygen from the air. So do some bacteria. But other bacteria get their oxygen in other ways. You cannot destroy all kinds of bacteria by keeping air from them.

Does covering leftover food destroy bacteria? In what way does covering food protect it from bacteria?

This machine is cutting peaches in half and removing the pits. Machines are used whenever possible in canning factories. *Below:* Jars of mixed fruit are filled by hand, but the workers are careful. Notice that they are wearing gloves.



U. S. D. A.

Meat is examined by United States Government inspectors before it comes to market.

Community Health Rules

Today very few people raise all their own food. The food that most of us eat has been raised by someone else. It has often been handled by many people before we eat it. How can we be sure it is free from disease germs?

To help provide us with a safe food supply, each state has a state health department. In some states there are county health departments, too. Then, most large communities also have a health department.

One of the jobs of the health department is to see that food is treated in as sanitary a way as possible. Sometimes restaurants are inspected. The inspector finds out how dishes are washed. He looks to see how garbage is taken care of. He checks on how food is stored. He makes sure the employees have a place to wash their hands and use soap, water, and clean towels before they handle food. Diseases such as typhoid fever can be spread by a food handler who has the germs but is not sick himself. Other people could get the germs from him and become sick.

In some communities, the restaurants are graded. Grade A means just what it would mean on a report card – excellent! The next time you stop in one of the restaurants near you, look to see if it is graded. Look to see what other things the restaurant is doing to prevent disease germs from spreading.

Some health departments require people who handle food in restaurants, grocery stores, dairies, and such places to have medical examinations.

For hundreds of years man knew *how* to prevent certain kinds of food from spoiling, but he did not know *why* foods spoil. He did not know about molds, yeasts, and bacteria.

FEELINGS ABOUT FOOD

Eat a good dinner and everything seems bright. The TV program looks better than ever. The comic strips seem funnier. Eat a good dinner and you think of sharing the new baseball glove with your brother after all. You begin to wonder if your sister was really as mean as you had thought she was. Eating has a great deal to do with how you feel.

But when you are hungry, you often become cross. You are easily annoyed. You are not quite as patient with the baby. Often your mood depends on how well you eat.

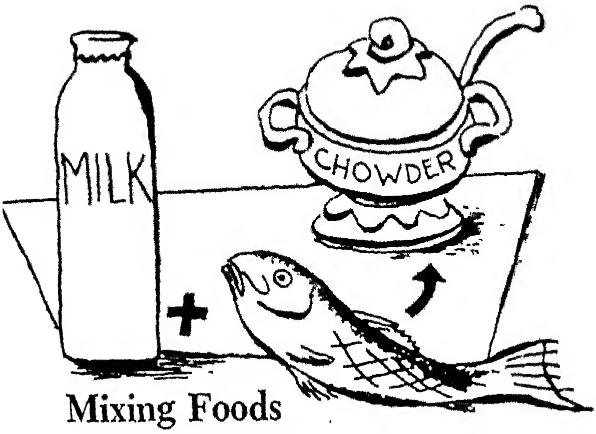
And you have feelings about foods in other ways, too. You have certain feelings about foods that you have never eaten. How would you like a meal of cooked beetles, seal blubber, or roast camel? Does it sound tasty? Maybe this is not your idea of a good dinner. But African pygmies eat beetles. Eskimos eat seal blubber. Arabs eat roast camel and they like it.

Why do you like some foods and dislike others? You started having feelings about food when you were a baby. If your big brother or your father seemed to like hamburger, you started to like it. Perhaps your mother did not like squash and seldom served it. When she did serve it, maybe she said something about not liking the taste or the way it looked. So *you* started to think that squash was not a vegetable to be enjoyed.

Many food likes and dislikes were formed when you were young. When the pygmy was a baby, he saw his mother and father eating cooked beetles. So he soon liked beetles, too. The Eskimo child saw his parents eating seal. The Arab child saw his parents eating roast camel. Children like to imitate their parents and other people they admire. This is true about eating as well as other things.

People all around the world seem to like different kinds of food. People in Scotland and a few other countries love stewed pigeon. Some Africans eat lizard eggs. Wealthy Chinese make a soup from nests of certain birds. People in Alaska eat reindeer chops. Italians like spaghetti and macaroni. Yet all these people can get the nutrients they need for good health from the foods in their own diets.

In most countries people are used to eating foods that grow best in their country. Chinese eat much rice because it grows well in China. In India the people eat a grain called millet. In the United States we use a great deal of wheat because we can grow it easily. Can you name other grains that are grown in the United States?



Mixing Foods

Has anyone ever told you not to drink milk when you eat fish? Has someone ever told you never to drink orange juice after milk? Do you think you will get sick if you eat pickles and ice cream?

There are many different ideas about mixing foods. Some of them started years ago, and people pass them along. Sometimes you will hear reasons that sound good. For example, some people say that orange juice turns milk sour. It does. But milk turns sour when it reaches your stomach even if you don't drink orange juice. There is a chemical in your stomach that sours milk. In fact, milk must become sour in your stomach in order for it to be digested. No mixture of foods is harmful to you. If a food is healthful, it can be eaten along with any other healthful food.

A good food will not upset you unless you overeat, are too excited, or are allergic to that food. But the way you feel about a food may affect your stomach. If you really believe a food is harmful, you may be upset by it.

There is a story about a man who was traveling in the West. He stopped for lunch at a friend's and was given a sandwich. It tasted very good. When he had finished, his friend told him that he had just eaten rattlesnake meat. The man suddenly got very sick. His feelings about rattlesnake stopped him from enjoying the sandwich.

Not many years ago people thought tomatoes were poisonous. They never ate them. Today we think it is silly not to eat tomatoes because we have found out that they are tasty and healthful. In years to come, some of our food habits today may seem silly, too.

Changing Food Habits

Eating properly is a problem for everyone in the world. In every land, scientists are trying to find new ways of helping people eat better.

Back on page 24 you read about a scientist who found a way to make flour out of fish. By using this flour, people could add new proteins to their diet very cheaply. But finding out how to make this flour was one problem. Getting people to eat it was another. Would you eat bread made from fish flour if you knew it was good for you?

To solve this problem, another scientist was called in. This scientist studied the diet and eating customs of the Mexican people. He suggested that the people would use the flour (1) if it didn't taste fishy, and (2) if it were used in some food they already ate regularly. He thought the new flour might be used in tortillas, a kind of pancake often served with a hot sauce.

It would be easier for Mexican people to accept the new flour served in this way.

You can learn to like new foods in the same way. If you now like only one or two vegetables, try a new one. But try it along with one you already like. If you don't like cooked cereals, try adding something you like to the cereal —perhaps brown sugar and raisins.

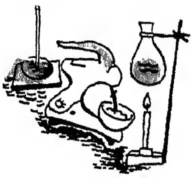
You can talk about your food dislikes in class. Perhaps someone else knows how a food you dislike can be prepared so you will like it. Three or four of you could try the food prepared the new way and report back to the class. It is easier to change food habits if you are part of a group trying to change.

Many food scientists spend their time working on these two problems: (1) finding out what foods are best for good health, and (2) getting people to want to use these foods.

Today Americans have more to eat than people in most other countries. Even so, scientists are not sure that our diet is as good as it could be. People living in some parts of the world don't have some of the diseases that we have. Food scientists compare the diet of these people with ours. They try to find out if the foods of these people make them healthier.

In this unit you have read about what scientists now think makes a good diet. Our diet is helping us grow taller and live longer than people used to. But there are still many questions to be answered. In the years to come we may have still better answers about what we should be eating.

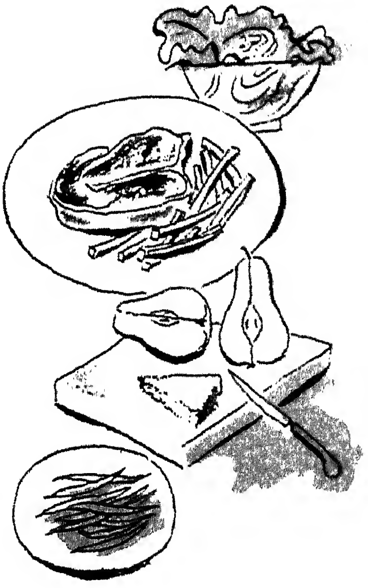
Things to Do



1. Collect food ads from magazines and newspapers. Read them carefully. How do they encourage you to eat certain foods? Do they list the prices? Do they tell you that famous people eat the foods? Do they tell you the nutrients the foods contain?

2. Some food experts say most Americans do not eat enough different kinds of foods. They say we tend to limit ourselves to bread, cereals, potatoes, and meat.

Here is what Dominique, a French girl, eats for dinner:

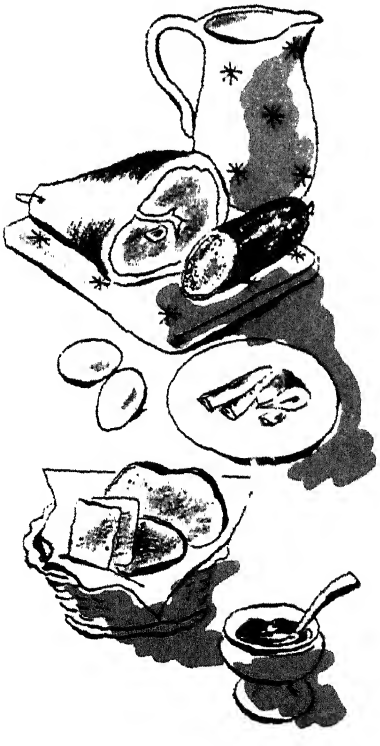


La salade de tomate	Les pommes frites
Le bifteck	Le fromage
Les haricots verts	Les fruits

Even if you can't read French, you can probably figure out what most of these foods are. The *bifteck* is steak, *haricots verts* are string beans, *pommes frites* are fried potatoes, and *fromage* is cheese.

How does Dominique's dinner compare in variety with yours? In which food group would you find each of her foods?

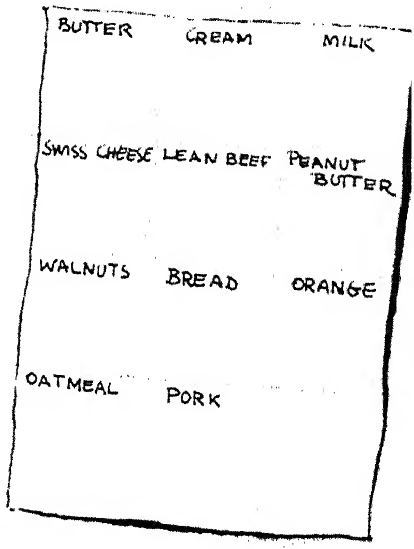
3. Now look at how Huldane of Norway begins the day. He comes down to a table set with many kinds of food. There are tiny crayfish, canned sardines, pickled herring, blueberry preserves, three kinds of dark breads, cold ham, cold salami, hard-boiled eggs, and big pitchers of milk. He can select what he wants. How does Huldane's breakfast compare with yours? In which food group would you find each of his foods?



4. Here is something you can do to see that minerals help to make strong bones. Save two tiny chicken bones the next time your family has chicken for dinner. Soak one bone in a glass of strong vinegar for two days. Vinegar is an acid and will remove the minerals from the bone.

Now compare the bone which has had the minerals removed with the bone which hasn't. Try bending each. How do they compare in strength?

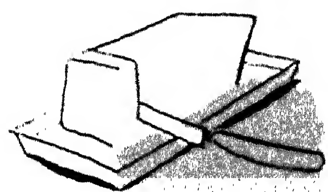
5. You can do some tests of foods to find out whether a certain nutrient is in the foods. Here is a simple test you can do for fats. Have different pupils bring in different foods to be tested. You might want to test butter, cream, milk, cheese, lean beef, pork, peanut butter, nuts, bread, oranges, breakfast cereal, or others.



Mark off some squares on a sheet of school paper as you see in the picture. In the center of each square rub some of the food to be tested. Write the name of the substance under each square. Then put your paper on the radiator to dry.

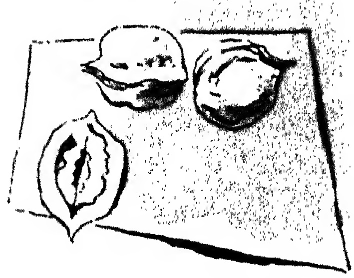
You will find that as some food substances dry, they leave an oily mark. It may be hard to find this mark for substances with little fat. You may have to let light shine from just the right angle to find the shiny mark.

Perhaps a committee can compare the amounts of fat in each food. For foods with no fat, or so little fat it doesn't show up on the paper, they can give a mark of 0 to +. Those that leave just a tiny trace of fat they can mark + to ++. Keep adding +'s as you find more fat.



6. You know that air has bacteria in it all the time. Here is something you can do to see how bacteria from the air look when they are growing. You will need:

- 1 package unflavored gelatin (from the grocery)
- 1 plastic container (like the kind cottage cheese comes in)
- a pinch of salt
- a pinch of baking soda

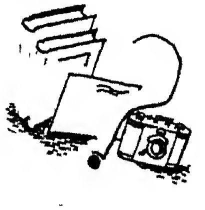


Prepare the gelatin as you are told in the directions on the package, but use a little less water than the directions call for. Add the salt and baking soda. Let the gelatin harden in a refrigerator. Study it from time to time with a reading glass.

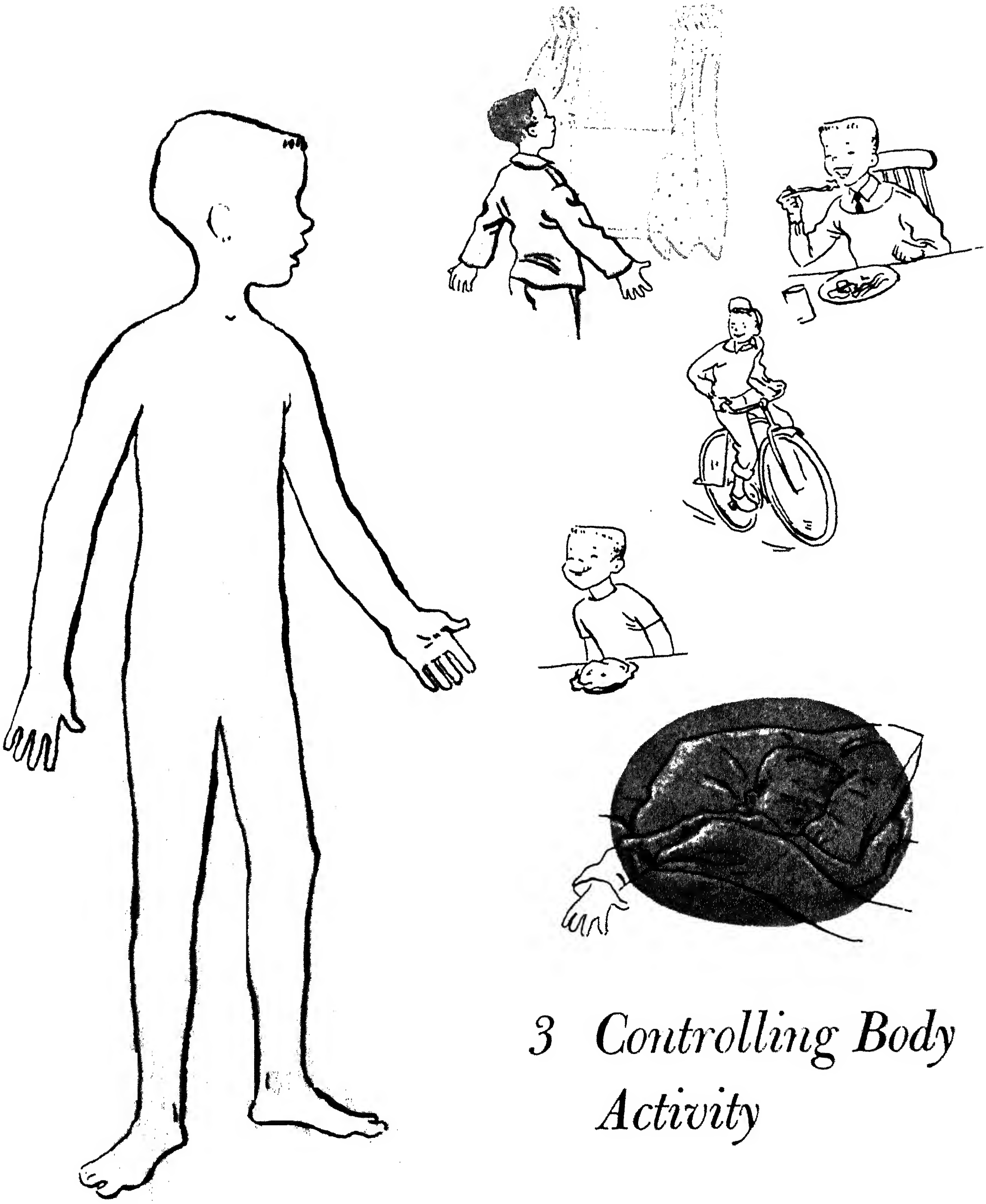
7. Your Board of Health or Health Department does many more jobs than the ones described in this chapter. Perhaps you can invite an official from the department to come in and talk to your class. What questions would you ask him about what his board does to make the community a healthful place in which to live?

8. Appoint a committee to visit the owner of a restaurant in your town. Have your committee find out what he must do in his restaurant to provide sanitary conditions. Make a list of the problems you would like the committee to find answers for.

If You Want to Find Out More



There is still another way you can study your own diet to see if it is a good one. You can see if you are getting enough food for the energy you need. Look up *calories* in a junior-high-school science book. What do calories tell about food? How many calories should you get from your food every day? Make a list of everything you ate yesterday. How many calories were there in each food? A cookbook will help you to figure this out. How many calories did you have in all?



3 *Controlling Body Activity*

About "*Controlling Body Activity*"

Man has invented many machines that do amazing jobs. Jet planes zoom across the sky. Giant electronic "brains" solve more arithmetic problems in two minutes than your whole class can do in two weeks! Atomic submarines can travel all around the world without coming to the surface once! But man has never been able to invent a machine as amazing as your body.

Think of the activities going on inside your body right now.

Your digestive system is working to change the food you ate to suit your body needs. At the same time, your heart is pumping blood. Your muscles are keeping you in an upright position. And other muscles are drawing air into your lungs for you to breathe.

When you finish this unit, you will understand more about how this wonderful machine—your body—works. You will find answers to such questions as these:

How can you make any part of your body move?

Can you taste things without smelling?

What makes a person see stars when he is struck?

KEEPING A BALANCE IN YOUR SYSTEM

Outside of Buckingham Palace in London, tall guards stand near their sentry boxes. They make a colorful sight in their bright red and blue uniforms and their tall fur hats. Tourists who come to London to see the sights stop to look at the guards. But it's more than the colorful uniforms that make the people stare so hard. The guards stand so still they look almost like statues. They hold their guns rigidly. Not a muscle moves in their faces. The tourists, especially the children, like to watch to see if they can catch a guard moving just a bit. Some of the children even tease the guards to try to make them laugh, but the guards pay no attention. Still and straight they hold their position, appearing not to move the least bit.

Thelma Johnson, Shostal

But do the guards move? Are they absolutely still? Can a human being not move? Try it. Try standing absolutely still while someone counts slowly to 100. Have your friends watch to see if they can catch you moving. What do you notice? Is it hard to keep from blinking? Do you feel a little twitch in your leg? Does an arm muscle give a little?

Keeping the same position is a strain on your body. Your body needs activity. When you stand or sit for a long time, you usually change your position so that different muscles do the work. The guard at Buckingham Palace has probably learned to rest tired muscles by moving only muscles that do not show.

Even sitting very still is hard. Watch a friend when he is reading. Does he lean first on one elbow and then on the other? Does he cross first one leg and then the other? Does he try slumping in his seat and then stretching way out? All these movements help to rest muscles when they get tired. Your body regulates itself without your thinking about it.

Not just your muscles, but other parts of your body must be regulated in the same way. When you run very fast, your body needs more oxygen. You breathe more quickly. If you play hard, you become warm. You perspire more. Your body loses water. You become thirsty. Then, when you drink water, the balance is restored to your system.

There is still another way in which your body regulates itself. In the unit before this you read of the French children who had poor diets during World War II. Because they had less food, they had less energy. So they were less active. They played fewer and quieter games than children who have a good diet. They were not told to do this by their parents. Nor did they decide to do this themselves. Their bodies adjusted to the poor diet in this way.

All Living Things Can Adjust to Changes

The human body is continually adjusting to changes inside and outside. So far, you have read about how your body adjusts to changes within it. Here are some ways your body adjusts to changes outside itself.

You perspire more on a hot day than on a cold day. You remember that perspiring helps cool your skin. Your body has adjusted to the outside change in temperature.

When you go into a room where there is little light, you cannot see very well at first. But soon the pupils of your eyes enlarge to let in more light, and you can see better. Your body adjusts to the change in the amount of light outside.

You remember that the body temperature of some animals, such as the turtle, changes with the temperature outside of its body. When the outside temperature is high, his body temperature is high. He becomes more active. When the outside temperature is low, his body temperature is low. He becomes less active. His body has adjusted to an outside change in temperature. Some warm-blooded animals, like bears, adjust to cold weather by hibernating.

Put a plant in a window. Make a drawing of the plant. Perhaps you can even take a photograph. Look at the plant again in a week. Observe its leaves and stems carefully. In what direction are they facing now? Compare it with your drawing or your photograph.

All living things have ways of adjusting to changes.

Like plants and other animals, humans adjust to many changes both inside and outside themselves. But human beings adjust to many changes better than any other living things. For example, when winter comes, a fox grows heavier fur. It finds a hole or a hollow log to live in. A frog buries itself in the mud at the bottom of a pond till spring comes. Many birds fly away to a warm place.

But human beings can build houses to live in. They can heat these houses. They can make clothing to wear. Human beings can adjust to changes by changing the world about them. They can do this because the human **nervous system** is more complicated than that of any of the other animals. Let's see how your nervous system helps you adjust to changes and helps you change the world about you.

National Audubon Society

The snowshoe rabbit in summer and winter. This kind of rabbit changes color when conditions around it change.

Your Nerves

Wiggle your thumb.

Can you explain what made it wiggle? Did you tell it to?

For any part of your body to move, a message must travel from one part of your body to another. These messages are carried over thin threads called nerves. The nerves are made of special cells, called nerve cells.

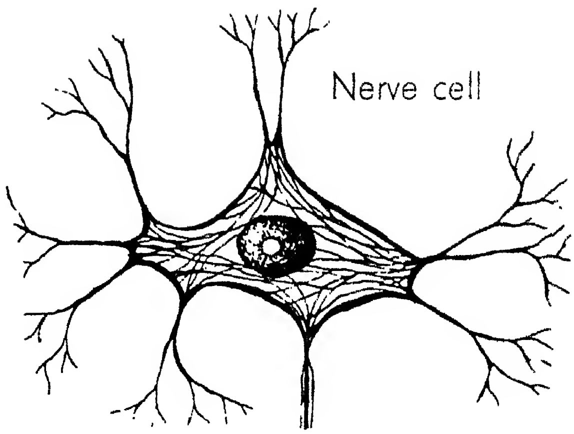
You know about some kinds of messages. When you speak to a friend on the telephone, your message travels by electricity at a speed of 186,000 miles a second. At that speed, it could travel around the world about seven times in just one second!

When you shout to a friend at the other end of the schoolyard, your message travels at a speed of more than 1100 feet a second. At that speed, it would take it about a day and a half to travel around the world just once!

A nerve message is different from the electrical message sent over the telephone. A nerve message is also different from a sound message when you speak or shout. Here are two ways in which the nerve message differs:

A nerve message travels along living cells.

A nerve message travels in only one direction in any single nerve cell, while an electrical message can travel in either direction along a wire.



In your body, a nerve message travels at a speed of about 300 feet a second. If you are five feet tall, a nerve message can travel from the brain to the toes and back again more than 30 times in a single second! You can see why the parts of your body can act so quickly. Nerve messages travel fast enough to make you do something at the moment you want to.

Different Kinds of Nerves

If you touch your finger with a pencil point, you feel it, of course. You feel it because a nerve carries the message of touch to your brain. You know that something pointed touched you even if you didn't see it.

Try this. Close your eyes and run your finger tips lightly over the desk top. You can feel every little bump along the desk. You can feel the individual grains of dust and other particles on the desk top. Can you guess why?

Now run the back of your hand lightly over the desk top. You will not feel nearly so many different bumps and specks of dirt with the back of your hand as with your finger tips.

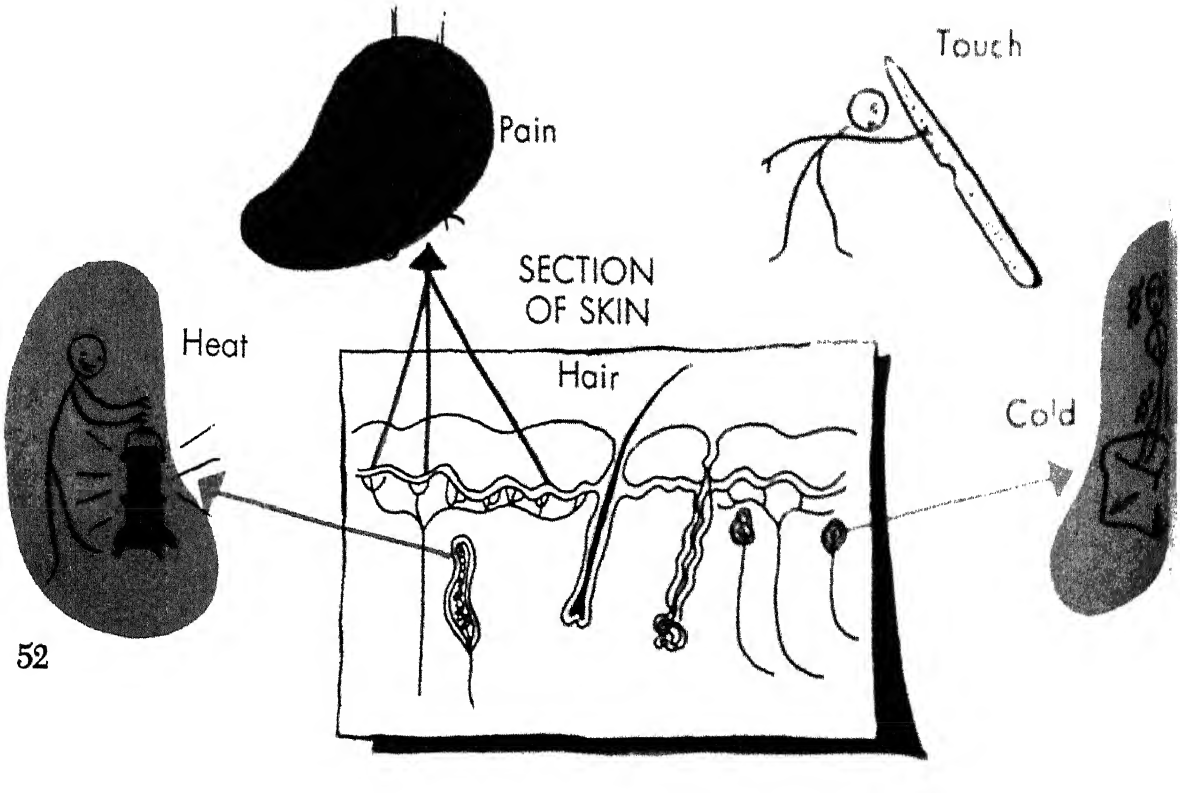
You may have noticed something strange when you tried this comparison. With your finger tips, you felt many small bumps and particles. But you did not especially feel coldness from the desk top. With the back of your hand, you did not feel bumps and specks of dirt, but you did feel cold spots. Try it again if you did not feel these cold spots with the back of your hand before.

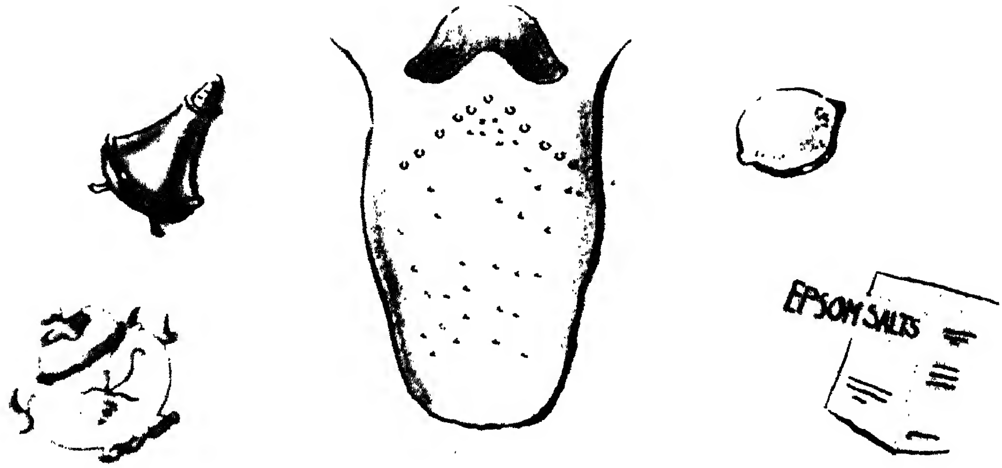
Try the same comparison with a piece of ice. Touch your finger tips to the ice. Then lightly run the back of your hand over the ice. What difference do you feel? What does this comparison tell you about nerves in your hand?

You may have guessed that there are several kinds of nerve endings in your skin. Some of them carry the message of touch. Some of them carry the message of cold. Other nerves in your skin carry messages of heat, and still others, pain. Each nerve in your skin carries only one type of message.

But you don't find out about things through your skin alone. You have other senses besides your sense of touch. There are nerves that carry messages from your eyes to your brain. Other nerves carry messages from your ears to your brain. You taste and smell things because of nerve messages.

Have you ever received a very sharp blow on the head? When this happens, you sometimes "see stars." You "see stars" because certain nerves in your head have been made active by the blow. Since these nerves carry only the message of light, you see "stars" before your eyes.





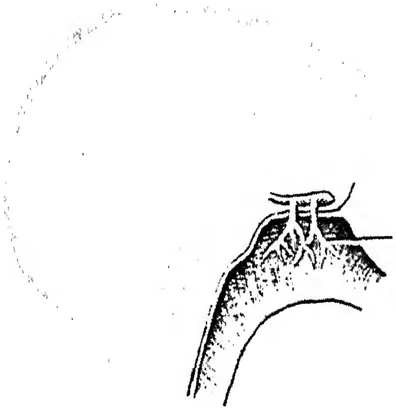
The Sense of Taste

Nerves that end in your tongue help you to taste things. And just as you have different kinds of nerves in your skin, you also have different kinds of nerves in your tongue. One kind carries the message of salty taste. Another kind helps you to taste sweet things. Others carry taste messages of bitter things and sour things. And, like your skin, different parts of your tongue have more of one kind of nerve ending than others. For some kinds of taste, there are more nerve endings near the tip of your tongue. For other kinds of taste, there are more nerve endings at the back or along the sides.

Perhaps you can figure out a way of discovering where the four different kinds of nerve endings along your tongue are located. On which part of your tongue do you taste most salty things? On which part do you taste bitter things? Sour things? Sweet things?

One way you can find out is by collecting four things that have these distinct tastes. Dissolve some salt in water for the salty taste. Get a lemon for sourness. Dissolve sugar in water for sweetness. Get some Epsom salts for the bitter taste. If you do this activity yourself, you will need a mirror.

Before you begin, dry your tongue with a clean handkerchief. If your tongue is very wet, the substance quickly spreads. This makes it harder to tell the exact spot on your tongue that receives each different taste message. Next, dip a clean, thin brush, like a very small paintbrush, into one of these substances and touch the very end of the brush lightly to different places on your tongue. Notice where you taste this substance best. A mirror will help you see the exact spot you are touching. Take a drink of water and dry your tongue with the handkerchief before you try the next taste. Do this for all four tastes. This activity will help you discover which part of your tongue has the most nerve endings for each taste.



The Sense of Smell

You have probably noticed that when you have a cold, you don't enjoy eating. That is because you need more than the nerve endings in your tongue to get the full flavor of anything you eat. Each food has a smell as well as a taste. The message from your tongue and the message of smell from your nose combine to give each food its own particular flavor. A bad cold prevents you from smelling things as well as usual.

The nerve endings for smell are high in your nose. Usually only a small part of the air you breathe passes over these nerve endings. If you really want to get a good smell of something, you must get the air up to the nerve endings high in your nose passage.

Have you ever noticed how a dog sniffs at something when he wants to smell it better? A dog's nerve endings for smell are high in the nose just as yours are. He sniffs the air up to these nerve endings to get a better smell of things.

Here is a comparison you can make to show how bringing the air high into your nose helps you smell things better. Take an orange. Nick the skin of the orange to release some of the odor, and hold it near your nose. First, breathe as you usually do. See how much you smell it. Then take a deep breath. Compare the smell of the orange when you breathe as usual with the smell when you take the deep breath.

Here's something else you can try with the same orange. Hold the nicked orange to your nose and smell it. The odor will seem strong. Keep the orange there for several minutes.

After a while, you will no longer smell the orange as strongly as you did at first. Is this because the odor from the orange is all gone? Or is it because your nerves of smell do not carry the message as well as they did when you first smelled the orange? Make another nick in the skin to release fresh odors to find out.

The nerves that carry the message of smell get "tired" after carrying one particular odor for a long time. They no longer carry the message of that smell so well. Do you remember coming into your house just before mealtime and smelling food cooking? Then, after a while you didn't notice the smell any longer. Your nerves of smell had become "tired" of that particular odor.

Your Other Set of Nerves

So far, you have found out about nerves that carry messages of taste, smell, and touch *to* your brain. These are sometimes called **sensory nerves.** But we still haven't found out how your thumb was able to wiggle. How did it get the message that made it wiggle?

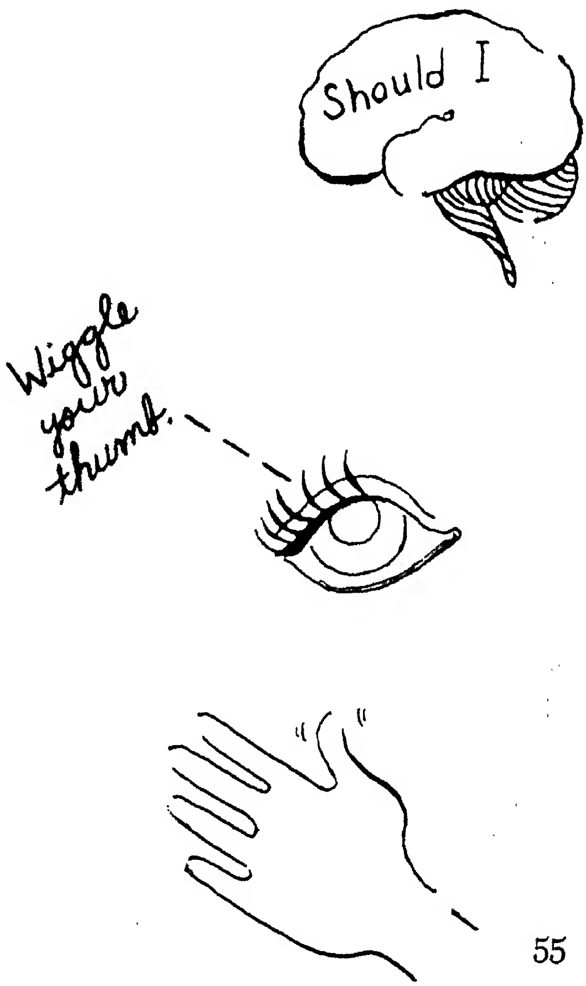
For any part of your body to move, you must use two sets of nerves. One set carries messages from your senses to your brain, as you have just read. Another set carries messages from your brain to your muscles.

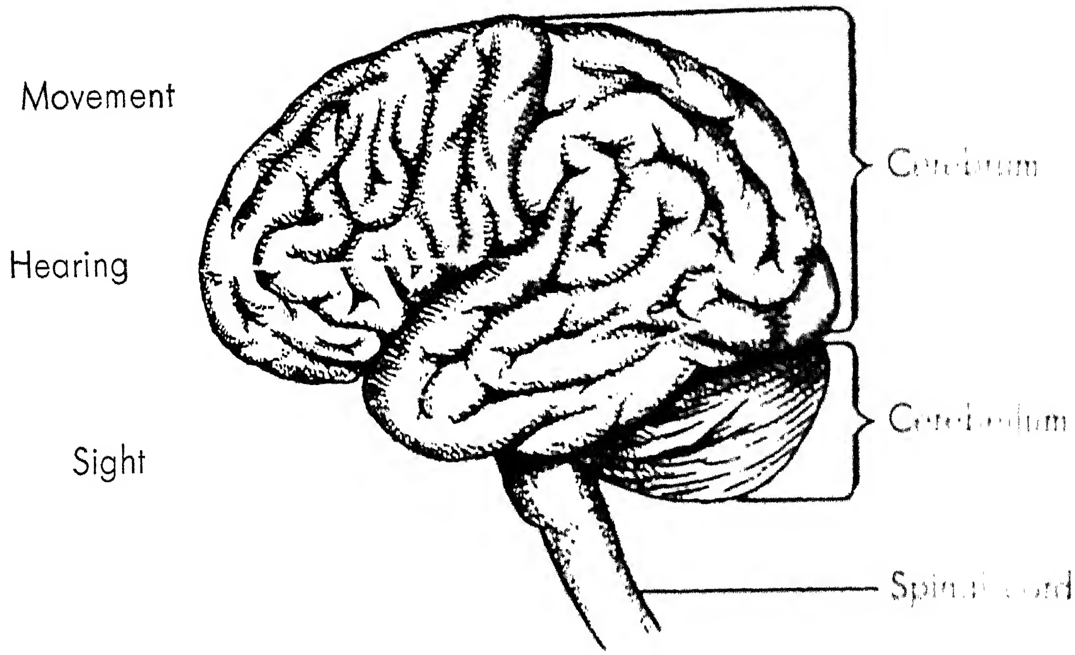
Let's see what happened in your body to make your thumb wiggle. With your eyes, you read: "Wiggle your thumb." This message traveled along nerves from your eyes to your brain. In your brain, you decided whether you wanted to wiggle your thumb or not. If you decided to wiggle your thumb, a message had to travel along other nerves to the muscles in your thumb.

These other nerves that carry messages away from the brain are sometimes called **motor nerves.** Before you kick a football, or pick up your books, or write your spelling words, or do any other activity, messages must travel along the motor nerves to your muscles.

These sensory and motor nerves are only part of your nervous system. We must talk about your brain and spinal cord next. Your brain and spinal cord are the center of your nervous system.

Messages are sent into the brain by the sensory nerves from all parts of the body. Orders come out from the brain on the motor nerves, making the different body parts do certain things.





Your Brain

Each part of your brain receives messages from a different part of your body. A message from your right thumb to your brain starts in the nerve endings in your right thumb, passes to the nerves in your spinal cord, and travels to the left side of your brain.

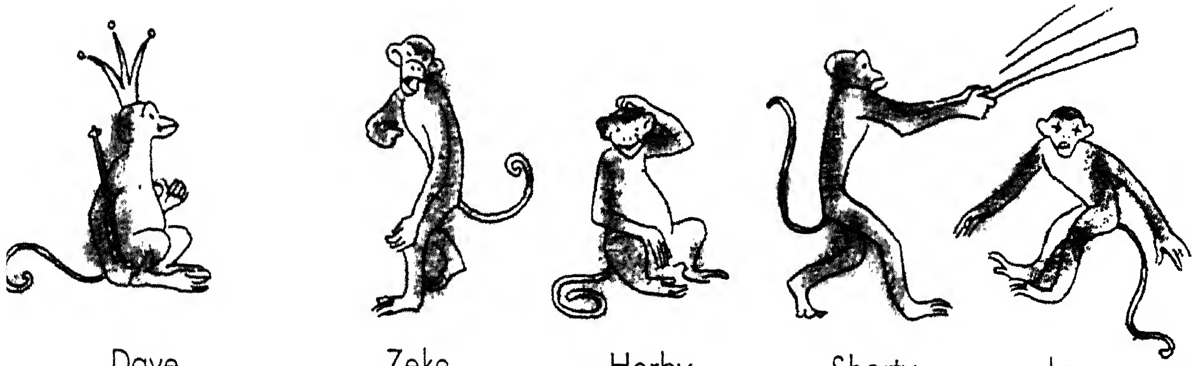
All messages from the right side of your body connect with the left side of your brain. And all messages from the left side of your body connect with the right side of your brain.

Notice the **cerebellum** in the picture. When a person's cerebellum doesn't work as it should, he can hardly walk. All his movements are jerky. The cerebellum automatically takes care of **coördination.** By *coördination* we mean smooth action of muscles.

Look at the **cerebrum** in the picture. The cerebrum is the part of the brain that thinks. It is the cerebrum that receives messages of sight, hearing, taste, smell, and touch and decides what they mean. It makes decisions and comparisons.

Scientists are trying to find out more about the cerebrum. They have found that it is possible to change a monkey's way of behaving by operating on its cerebrum. First, they observed a group of monkeys and made notes about how they behaved. Look at the pictures on the next page and you will see what they noticed.

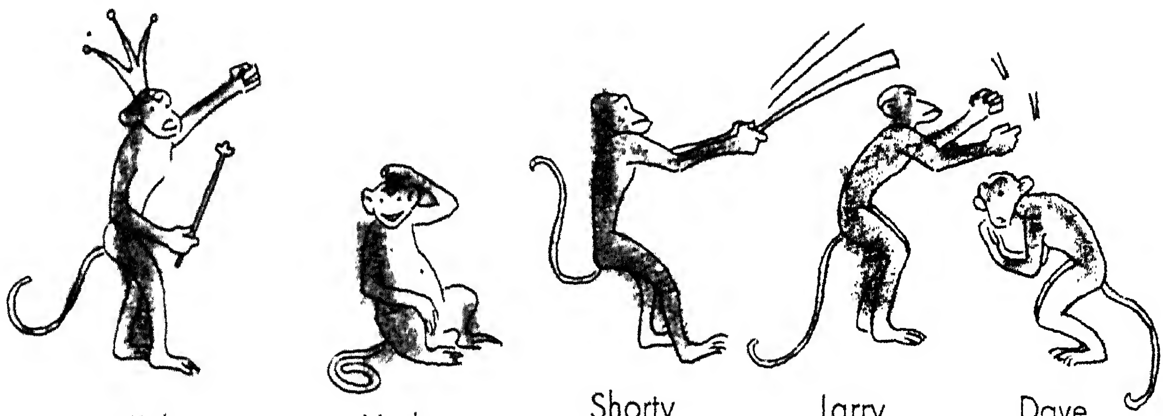
Dave was the Number 1 monkey and the boss of the group. The other monkeys feared him. Larry was the most timid of them all. He was the last in the group.



Dave The Boss | Zeke A Fighter | Herby Quiet | Shorty Attacks Only Larry | Larry A Coward

BEFORE

Then an operation was performed on Dave's cerebrum. Notice where Dave is in the group now! He is no longer the Number 1 monkey but has dropped to the very bottom of the group. Even Larry, who was the most scared of all the monkeys in Picture 1, can now boss Dave around. Larry didn't have an operation, but he changed, too, when he had someone weaker to pick on!



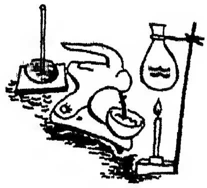
Zeke New Boss | Herby Still Quiet | Shorty Still Attacks Larry | Larry Now Attacks Dave | Dave Now A Coward

AFTER

In still another experiment, scientists removed most of the cerebrum of a frog. The frog still hopped around. It digested food. In fact, the frog was able to carry on almost all its activities and go on living for several weeks.

There are many things still to be learned about the brain. As man learns more, it will be possible to help people with brain injuries. We will know what it is possible to do to the brain and what not.

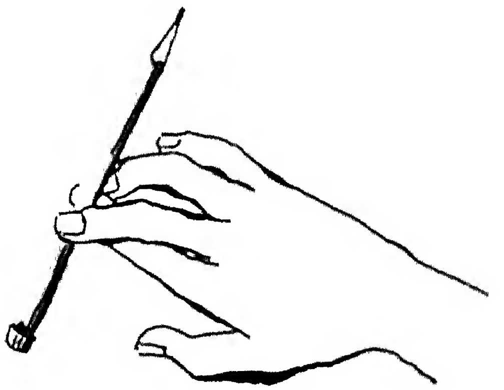
Things to Do



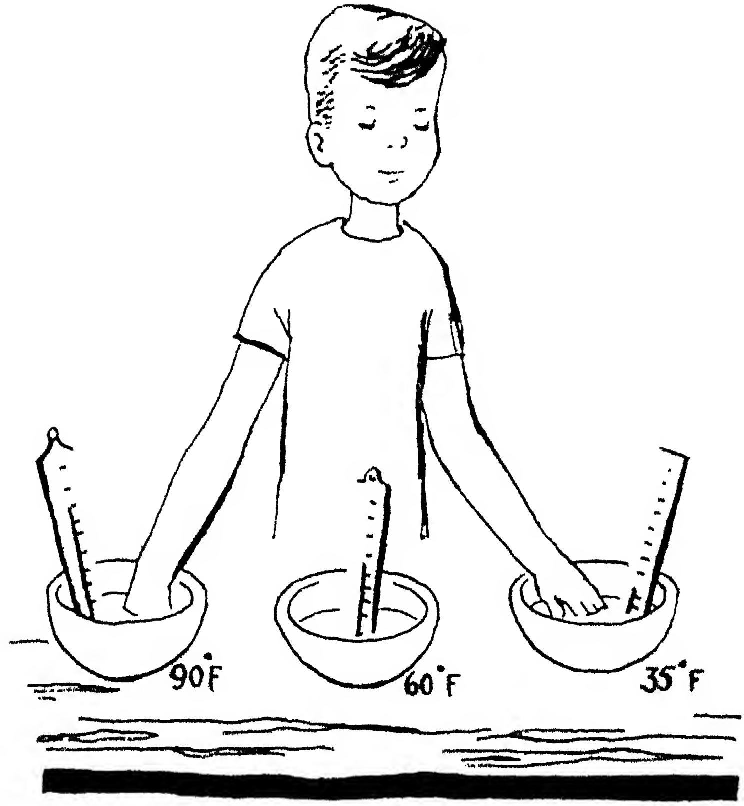
1. Try to find out where different kinds of nerve endings are located on your skin. With a very sharp toothpick or pencil point, lightly tap a section of skin on your hand or arm. With some taps you will feel very little. With other taps you will feel coolness. With still others you will feel a slight pain.

2. Are there more nerve endings for the message of cold on the underside of your wrist than on the top-side? How can you find out? (Have you ever seen a mother test the temperature of milk before giving it to her baby by sprinkling some of the milk on her wrist?)

3. Get a small pea. Hold it between your crossed fingers as you see in the drawing. Close your eyes and move the pea slightly. It feels like two peas instead of one! Slide a pencil between your crossed fingers and you will feel two pencils.



Here's the reason. Ordinarily, the two parts of your skin touching the pea don't touch the same object. They don't usually carry the same message at the same time. When you cross your fingers, these two parts of your skin do touch the same object. But it still seems to you as if the messages are coming from separate objects—just as they usually do from these two places.



4. Whether something feels hot or cold to you depends on a comparison. Try this. Get three bowls. In the first bowl put warm water—about 90°. In the middle bowl put water that's about 60°. In the third bowl put cold water—about 35°. Put one hand in the first bowl and your other hand in the third bowl. Keep them there for thirty seconds. Then put both hands in the second bowl. How does the water in this middle bowl feel to each hand?

Things to Talk About

1. There are more nerve endings for the message of heat on your lips than on other sections of your body. How do these nerve endings on your lips help to protect you?

2. A dog has a much bigger area of the brain for the sense of smell than man. How does this difference affect the dog's behavior compared to man's?

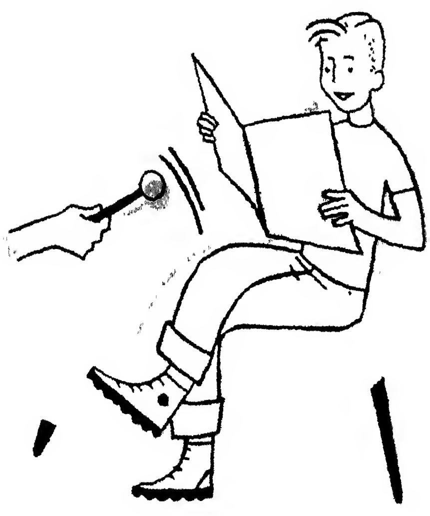
DOING THINGS WITHOUT THINKING

Imagine what your life would be like if you had to think about things such as keeping the same body temperature, taking a breath, or making your heart beat! You would spend every moment thinking about these activities with no time left for watching TV, or playing ball, or talking to friends.

And what would happen if you didn't remember to digest your food? It's not so bad if you forget to wash your face a few times, but what if you forgot to make your heart beat? What would happen if you suddenly got tired of breathing?

Your body does many important things that you never think about. Your cerebrum does not tell your body to do these things. How, then, does your body do these things?

You have already read how your nerves control the movements of your arms and legs. There are other nerves that control your heartbeat and your digestion.



What happens when something irritating gets into your nose? What does your eye do if an object is coming toward it fast? Cross your legs and have someone tap you lightly below the knee with the edge of his hand or a large stick. When your friend hits a certain spot below your knee, your foot kicks out. You don't even realize your foot kicks out until you see it!

You start each of these activities without thinking about it. The nerves that control these automatic activities do not go into the cerebrum. The messages that start these activities are picked up by nerve endings and travel to your spinal cord. From your spinal cord, a message goes out that makes you sneeze, or blink your eye, or kick your foot out.

This kind of nerve message is called a **reflex**. Sneezing is a reflex. So is blinking your eye when an object comes toward it. The reflex you tried is called the knee-jerk reflex.

Reflexes keep your body operating smoothly. The eye-blinking reflex protects your eye from dust and flying objects. The sneezing reflex clears your nose of irritating objects.

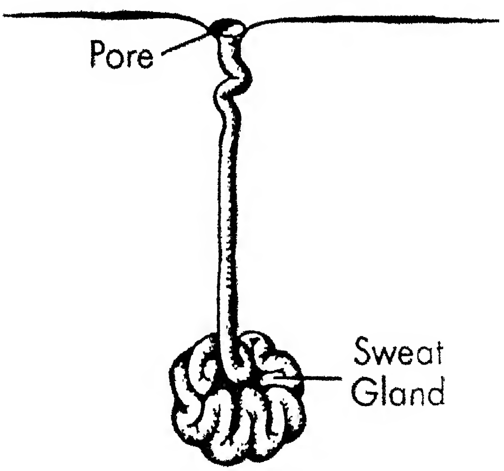
Other reflexes are useful, too. If you accidentally touch a hot object, you pull your hand away immediately. You pull your hand away even before you are aware that you have touched something hot. The action is a reflex that your body does automatically. The reflex protects you from certain kinds of burns.

Body Temperature

You have read that your body stays at about the same temperature at all times. This is something else your body does without your thinking about it. You can take your temperature at different times to see how true this is. Take it when you get up in the morning. Take it after playing hard. Take it on a warm day and on a very cold day. Take it just before you go to bed at night.

You will probably find that your body temperature does change during the day—but only slightly. You will find that your temperature is a bit higher immediately after you exercise. You may also find that other boys and girls have a temperature different from yours, even though you are all perfectly healthy. But you will also discover that your temperature and your friends' temperatures seem to stay about the same—between 98° F. and 100° F.

You remember that one way your body keeps a steady temperature is by perspiring. You perspire more when it is warm. Nerve endings in your skin carry the message of heat to the center of your nervous system. A message travels back to your skin and makes you perspire. Water is collected in your skin in thousands of **sweat glands.** It comes out of tiny openings in your skin called pores. The moisture spreads over the surface of your body.



How does this help to keep your body cool? Here is a way you can find out.

Take two cloths of the same size. Soak one in water and hang both cloths in the same place. Let them hang for five or ten minutes. Then feel them. Which cloth feels cooler? Why?

Try this, too. Take two thermometers. Keep them in the same spot for a while and check them to see if they both read the same. Now wrap some cloth around the bulb of one and let one end of the cloth hang in water, as you see in the picture. That will keep the bulb of one thermometer wet.

After five or ten minutes, read the thermometers again. The thermometer with the bulb wrapped in wet cloth will be at a lower temperature than the other. You have discovered that when water evaporates from an object, the object becomes cooler.

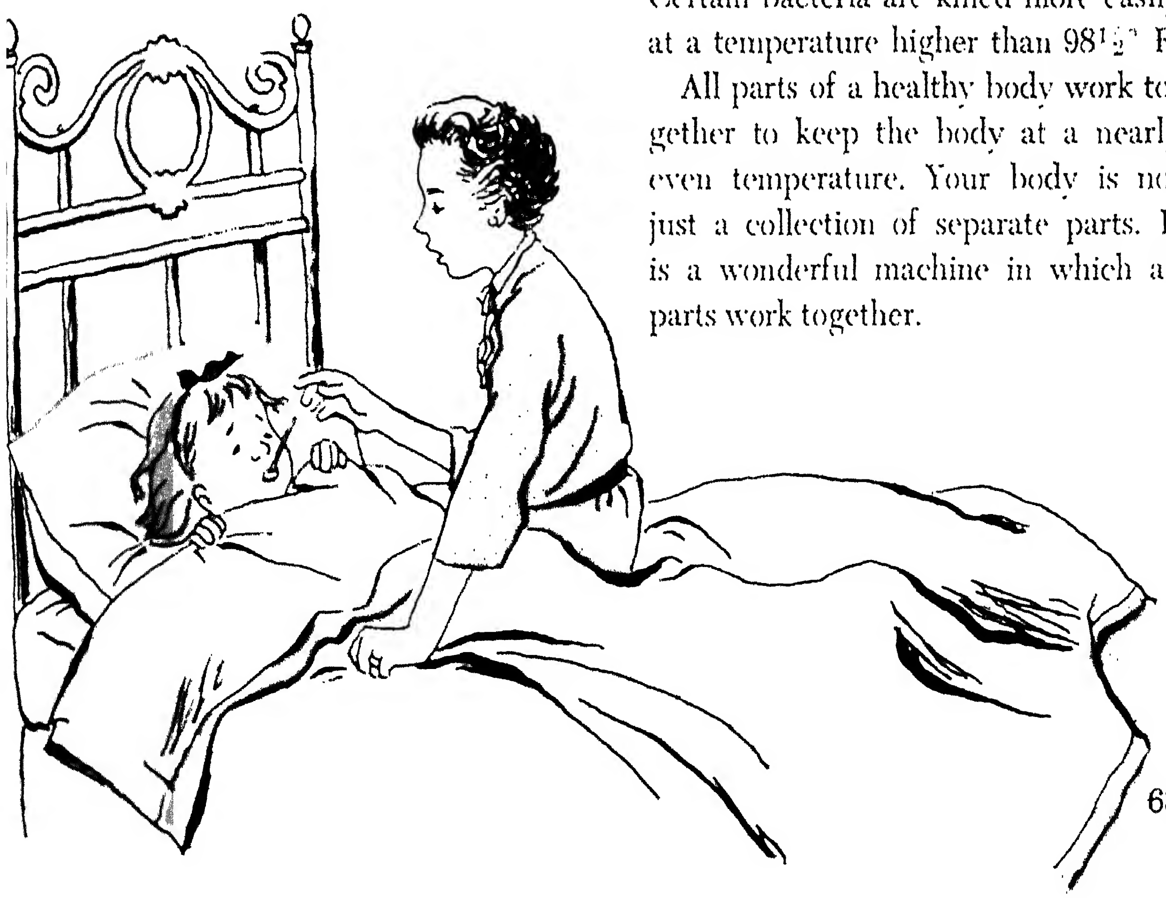
The hotter it is, the more you perspire. The more water that evaporates from your skin, the cooler your body surface becomes. You can see that perspiring helps your body remain at about 98½° even on a hot day.

There is another way in which your body loses heat. Has your mother ever said, "Sit down for a while. You're getting overheated"? She can tell when you are very warm without actually touching you.

When you are warm, the blood vessels just under your skin automatically become larger. As they become larger and carry more blood, you flush. But here's what happens that makes you get cooler when you flush. Much of your body heat is passed from your blood to your skin. Your skin, in turn, gives off heat into the air, just as a stove or any other warm object does. Your body cools down. Perspiring and flushing are two automatic actions that help to keep your body at a steady temperature.

What happens when the air around you is cold? The blood vessels just beneath your skin automatically become smaller. They carry less blood. Not as much heat is passed from the inside of your body to the skin and on into the air. This action of your blood vessels helps keep heat inside your body on cold days. This action is controlled by nerves.

Have you ever shivered so much you couldn't talk? Shivering is still another means your body uses to stay at about the same temperature. When you are chilly, the muscles in your arms, legs, and face become tense. When your muscles become tense, they produce more heat. You become warmer. If you get very chilly, your muscles become so tense that you begin to shiver. Shivering produces still more heat and helps keep body temperature steady.

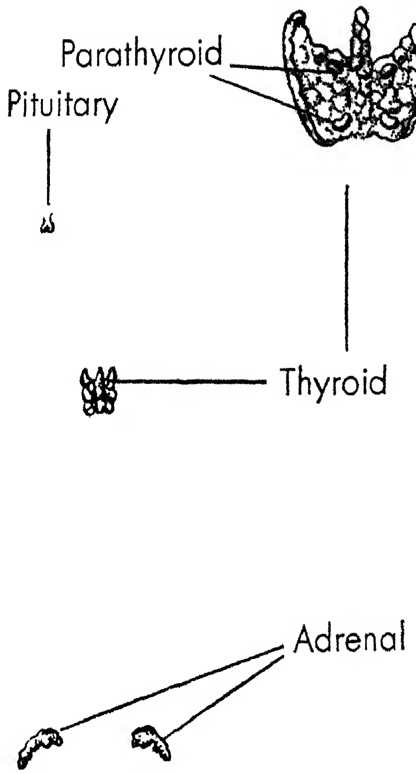


Fever

When you are ill, your temperature may be higher than usual. You have a **fever.** You have a fever because your body does not lose heat as rapidly as it usually does. Normally, when you get warm, blood vessels near your skin become larger. More blood flows through them. Heat passes from your blood to your skin, then into the air. But when you have a fever, the blood vessels near the skin get smaller, just as they do when you are cold. For this reason, you sometimes get chills when you start to get fever, even though your body is not cold at all.

Some scientists think that a higher body temperature helps fight disease. Certain bacteria are killed more easily at a temperature higher than $98\frac{1}{2}$° F.

All parts of a healthy body work together to keep the body at a nearly even temperature. Your body is not just a collection of separate parts. It is a wonderful machine in which all parts work together.



The Glands

Some of the things that happen in your body are not controlled entirely by nerves. They happen because of certain chemicals produced in your body. These chemicals are produced in parts of your body called **glands.**

Have you ever been so scared or so excited that you did something you wouldn't ordinarily be able to do? There is a newspaper story that tells of two women alone in a house when a fire broke out. The two frightened ladies lifted their piano and carried it outside. Later it took five men to carry the piano back into the house!

Of course, the piano might have been a small one. But still, everyone's body *is* able to produce a great amount of extra energy in an emergency.

When you are suddenly frightened, your heart beats faster and you breathe more rapidly. More sugar is released into your blood to give you energy. These changes make you better prepared to meet an emergency. When you breathe faster, your body gets more oxygen. When your heart beats faster, the blood travels faster. It furnishes each cell with more food and oxygen so that it can produce more energy.

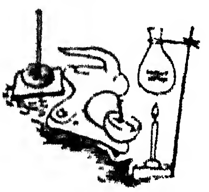
These automatic changes in your

body are caused by a chemical released from your **adrenal glands.** They release their chemical directly into the blood. You have two adrenal glands, one on each side of your spine just above the small of your back.

Other glands cause different automatic actions. The **pituitary** gland near your brain releases a chemical into your blood that controls how rapidly you grow. In fact, the chemical from this gland is absolutely necessary for growth. The **parathyroid** glands in your neck control the way your body uses the mineral calcium. The **thyroid** gland in your neck controls how rapidly your body uses up energy. All of these glands do their work by releasing special chemicals into your blood.

You have seen that your body controls in two ways the things you do without thinking. Your nerves and your glands work to keep your body running smoothly.

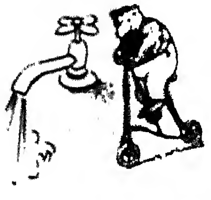
Things to Do



1. You can feel the cooling effects of evaporation on your skin by putting a few drops of water on your wrist. Alcohol evaporates faster than water. Would evaporating alcohol make your skin feel even cooler than evaporating water? What experiment can you plan to find out? How can you be certain both the alcohol and the water are the same temperature to start with?

2. In hospitals, nurses keep a temperature chart for each patient. Find out from a nurse or doctor how doctors use these charts.

Things to Talk About



1. Why is it hard for you to keep cool on a muggy day?

2. Why do football coaches sometimes tell their players to "get mad"?

3. Why is it uncomfortable for your eyes when someone suddenly puts on a light while you are in a dark room?

To keep your body operating smoothly, your nervous system must remain healthy. Your nervous system consists of your brain, your spinal cord, and your nerves.

You have read that certain vitamins in the food you eat keep your nervous system working properly. Vitamin B_1, or thiamine, prevents a disease of the nervous system called beriberi.

Vitamin B_1 is found in cereals, whole-wheat bread, eggs, and pork. It is also found in enriched bread. A person who eats these foods regularly will not get beriberi. But the entire diet, not only vitamin B_1, is important to keep the nervous system healthy.

Coffee and Tea

Have you ever been told that coffee and tea aren't good for you? Children are often told to avoid these drinks. Coffee and tea have no value as food. They don't help you grow new cells. They don't give you energy. If you do drink them, they may spoil your appetite for foods your body really needs.

Coffee and tea contain a chemical called caffeine that works directly on your nerves and peps you up. Perhaps you are wondering what's wrong with feeling peppy.

You need a certain amount of rest. When you rest, you digest food more easily. When you rest, your body cells get the time to repair themselves. Waste products that form in your cells are removed by your blood. This process takes time. And it requires a resting body.

What would happen if you never rested? Gradually, your body would wear out and you would become very ill. For this reason, the feeling of being tired is important to your health. It is a signal that you need rest.

A person who drinks coffee or tea may not feel tired when his body needs rest. The coffee or tea peps him up. His body needs the rest, but he doesn't feel like resting. Lack of rest may even lower the resistance of his body to certain diseases.

Many adults have found that drinking coffee or tea prevents them from getting the rest they need. They avoid these drinks in the evening for this reason.

Children usually need more sleep and rest than adults. All young people should find time during the day, as well as in the evening, to relax and do something calm. If you drink coffee or tea during the day, it may prevent you from relaxing. If you drink it in the evening, it may prevent you from getting restful sleep.

Rapho Guillumette

Just about everybody needs sleep.

Sleep, Rest, and Activity

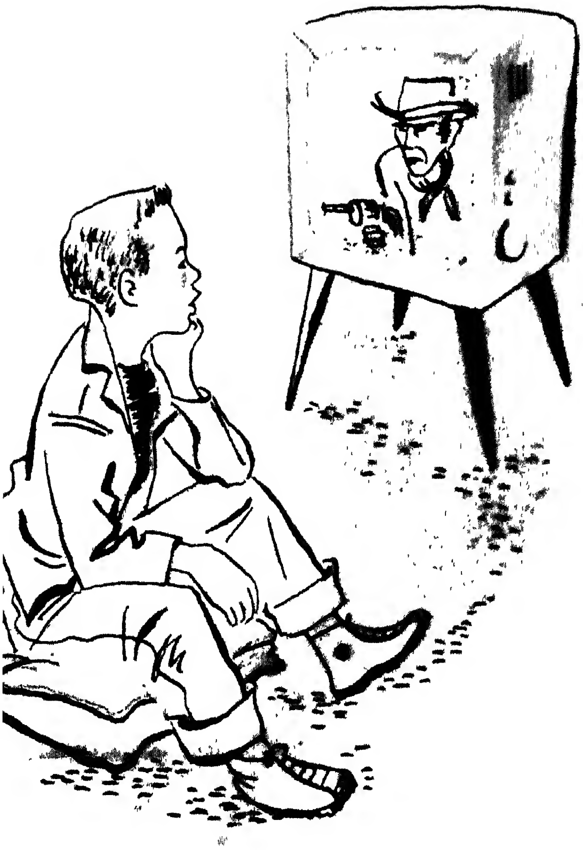
You keep your nervous system healthy by eating the proper foods. You keep it healthy by avoiding coffee and tea. Every day you do still other things to keep your nervous system healthy. You rest and you exercise.

After a great deal of activity, you feel tired. Even after a quiet day you may still feel tired. Even if you don't seem to be working hard, your brain is working. You are looking at things. You are listening to things. You are thinking. All these activities of your nervous system can make you feel tired. Feeling tired is a sign that your body needs rest.

When you relax, your muscles move less than they do at other times. But the thinking part of your brain is still working. You also need to relax the thinking part of your brain to keep your nervous system healthy. The only way to relax the thinking part of your brain is to sleep. No one can live without sleep. Animals die after a few days without it.

While you sleep, your breathing becomes deeper. Your heart beats more slowly. Many of your reflexes do not work. During sleep you don't smell or taste very well. You don't feel things or hear sounds as well as you do when you are awake. The entire thinking center of the brain does not work as actively as it does when you are awake. Your body can get the rest it needs.

Perhaps you need ten hours of sleep every night. Perhaps you need ten and a half or eleven hours each night. You cannot tell from a book or a chart exactly how many hours of sleep your



body needs. Each person is different. A good rule to follow to find out how much sleep you need is this: Go to bed early enough so that no one must wake you in the morning. If you get up at just about the right time every morning without needing someone to wake you, you are probably getting enough sleep. If someone must wake you each morning, try going to bed a little earlier. If you get up too early each morning, try going to bed a little later.

Some people go to bed early enough, but they do not fall asleep right away. Sometimes the reason they stay awake is that they are too excited. They are thinking about all the things they did during the day. To help you fall asleep more easily, try to do something calm for an hour or two before going to bed. Play a quiet game for a while, or read a book, or listen to a radio program of soft music.

Your nervous system regulates all the things your body does. With your nervous system, you see, hear, smell, taste, and feel. With your nervous system, you control the movement of all the parts of your body. With your nervous system, you figure things out, you imagine things, you think.

Good care of your nervous system makes it possible to do all these things. Good food and plenty of exercise and rest help your nervous system do all its necessary jobs.

Polio, a Nerve Disease

When a person is first ill with polio, he feels sick all over, but he has no **paralysis.** When someone has a paralysis, he cannot move his arms or legs normally. Most people who have polio get well without any paralysis setting in. In only a few cases do the germs get into the nerves and cause paralysis of the arms and legs. Often, the paralysis clears up in a few weeks, but sometimes it remains.

Today you can get shots that help protect you from polio. People do not fear polio nearly as much as they once did. The shots have reduced the number of cases of this disease.

The polio shot is called a **vaccine.** It contains dead polio germs. The dead germs in the vaccine make your body produce chemicals that protect you from live polio germs. There are other vaccines that protect you from other diseases.

The Story of the Polio Vaccine

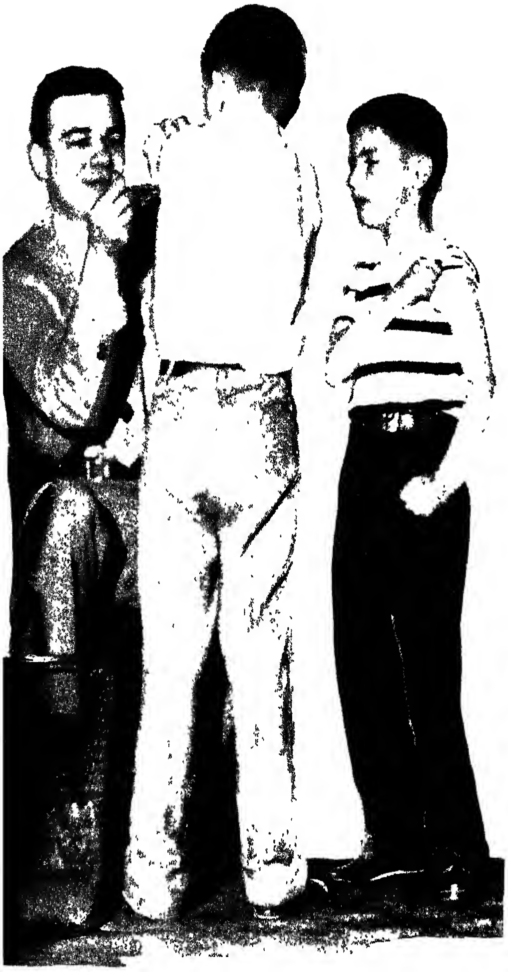
Before a scientist can make a vaccine, he must find a way to grow the germs. It took a long time to make a polio vaccine, because polio germs will not grow on gelatin or in broth the way many germs will. Finally, scientists discovered that polio germs will grow in cells which have been taken from monkeys. Then Dr. Jonas Salk made a vaccine by growing a lot of these germs and killing them with a chemical.

Next he had to see whether the vaccine was safe and whether it would protect people from the disease. Of course he didn't want to give the vaccine to people until he was sure it was safe. He gave it to monkeys which are the only animals besides man who can catch polio. Dr. Salk found that the monkeys were not harmed and that they were protected against polio. But he still could not be sure the vaccine would work the same way for people.

Dr. Salk gave the vaccine to 161 people who volunteered for this important test. They were not harmed. Blood tests showed that they were probably protected against polio. But still this did not prove that the shots would surely protect people in a real epidemic. Doctors had to give shots to thousands of children to prove this.

First, the doctors selected the schools for the experiment. They selected schools in the city, schools in the suburbs, and schools in the country. They selected schools from every state. Why was it important to select schools from all over the country?

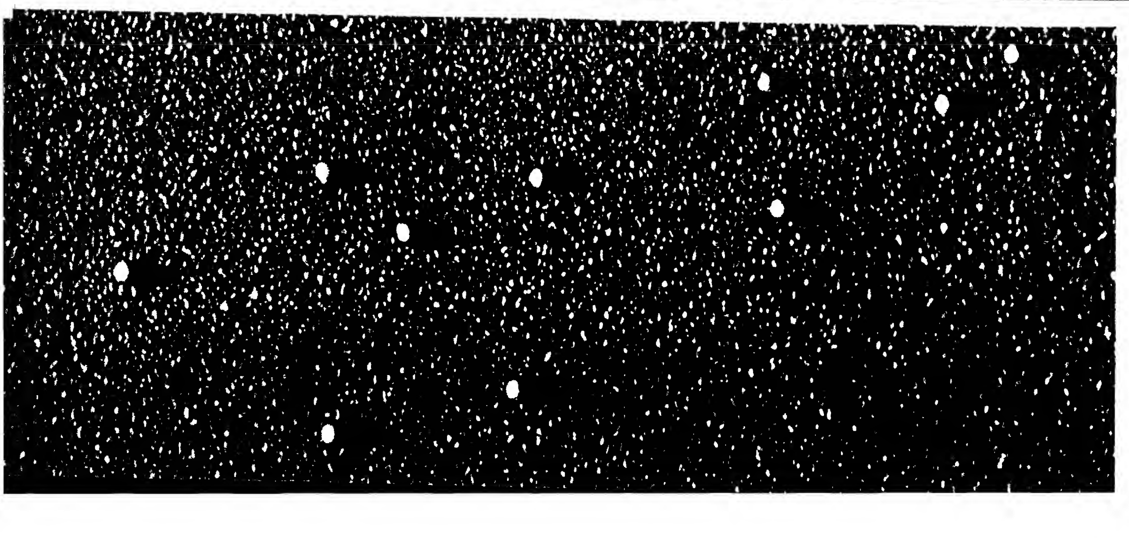
While the doctors selected the schools, large vaccine-making factories produced the vaccine that was needed for thousands of shots. Doctors in all the towns chosen for the experiment



Photos, National Foundation for Infantile Paralysis

Below: Dr. Jonas Salk. Left: These children helped test Dr. Salk's polio vaccine in Virginia.

Polio virus, enlarged 100,000 times. Like other viruses, it is so tiny that it can be seen only through very powerful microscopes.



got ready to give the vaccine. Teachers and mothers helped to get things ready for the huge experiment.

More cases of polio occur in the summer than at any other time. The doctors decided to give the shots during the spring. Then they would see how many cases of polio occurred during the summer. If few cases of polio broke out, it might mean that the vaccine was helpful in preventing polio. But how could the doctors be absolutely sure that the vaccine had prevented other cases? Maybe only a few cases would have broken out anyway.

To make sure they were testing the effect of the vaccine only, the doctors had to include another part in their experiment. They decided that while they would give most of the children the vaccine, they would give some of the children no vaccine. These children would get a shot of plain water only. Let's see how giving some children just plain water improved the experiment.

Some children received vaccine. Some children did not. At the end of the summer, the doctors made a comparison. How many children who received the vaccine got polio? How many children who received the water shots got polio? By making a careful comparison, the doctors found that children who had the real shots had many fewer cases of polio. Their comparison showed that the polio vaccine worked. Only by making a careful comparison could the doctors find out whether the vaccine worked. Experiments require careful comparisons.

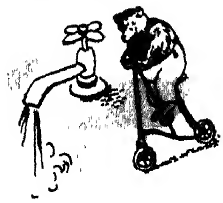
Today, thousands of children and adults receive the polio vaccine. It has greatly reduced the number of cases of this harmful disease of the nervous system.

Things to Do

1. Keep a record of how many hours of sleep you get. You might also keep a record of the sleep you get during a week in December and a week in April to see if there is a difference. Compare your records with a friend's to see if some need more sleep than others.

2. Observe a younger child at different times for a few days. How many more things can you do because your nervous system is more developed than his? If you have a younger brother or sister, you will be able to observe easily.

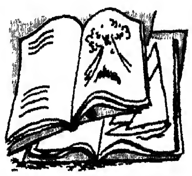
Things to Talk About



1. Do people who are very active need more sleep than those who aren't so active? What could you do to find out?

2. Have you ever had swollen glands in your throat? When did you have them? Why do you think they swelled?

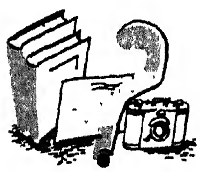
Things to Read About



1. Try to find out how many polio cases used to occur in your community each year before polio shots were used. How many occur now? To find out, you might write to your County Public Health Officer at the county seat. You might write, too, to the State Department of Health at the state capital.

2. Find out what other diseases are prevented by vaccines.

If You Want to Find Out More



You can do an experiment to find out how we depend upon both of our eyes to see things well. Take the cap off a fountain pen and hold the pen in your left hand at arm's length. Hold the cap in your right hand. With your left eye closed, try putting the cap on the pen. Can you do it the first time? Now try it with the right eye closed. Are you any better?

Test some of your classmates. How do they differ in being able to do this?

Can you improve by practicing?

4 *Developing Science Hobbies*

About *"Developing Science Hobbies"*

You've been reading about the work of many different scientists. Perhaps you've wondered what makes a person decide to become a scientist. How do scientists get started in science?

We need many, many scientists to think up new and better ways of doing things. We also need people who will work in laboratories to help scientists carry out their important work.

Because of the great need for scientists today, psychologists have wanted to find out how more boys and girls could become interested in science. They have studied the lives of famous scientists. They find that scientists begin their interest in science when they are still very young. Many of them have hobbies that get them started.

In this unit you will read about some hobbies that can help you learn more about science. You will find out how you can become better at comparing things, testing ideas, measuring changes, and doing many other things that scientists must learn.

HOW DO YOU START A HOBBY?

Donna started keeping a record of unusual birds in her neighborhood. Birds are pretty, and she wanted to know them by name. She wanted to find out which ones came to the nearby park during different times of the year. She wanted to find out what foods they ate and where they built their nests. The more she found out about these things, the more interested she became. Birds became her hobby, and she learned many things in studying them.

She had to find the best places to observe birds. She made comparisons to see if birds were easier to find at certain times of the day. She kept careful records to see whether the summer birds in her neighborhood were the same as the winter birds. She kept records of the feeding and nesting habits of the birds. In doing these things, Donna had become a young bird scientist.

Arthur's hobby is raising tropical fish. His uncle got him started by giving him an aquarium and several fish. Before long, Arthur wanted to see if

he could raise his own fish. He found out all he could about setting up an aquarium to raise guppies. Soon he was raising black mollies and other tropical fish. He also learned many scientific facts about different kinds of tropical fish.

Diana's hobby is baking. She started this when she was little by helping her mother in the kitchen. She enjoys her hobby because of the fun she has sharing it with her friends. She likes to try new recipes and to make up recipes.

Diana has learned a great deal of science through her hobby. She experiments with many different things. Sometimes she changes the amount of something called for in a recipe to see what difference it makes. She also tries different types of baking tins to see if some are better to use than others. From time to time she changes the temperature of the oven to see if that makes a difference. She tests ideas in the kitchen in the same way a scientist tests ideas.

Bob collects insects. He has a collection of many different kinds. By collecting and reading about insects, he has learned a great deal about them. One fall he found several praying mantis egg sacs on plants in a field near his home. He had learned that praying mantises are useful in a garden because they eat harmful insects. He also knew that each sac contains more than fifty eggs. He decided to collect the egg sacs and put them in his family's garden.

When the neighbors saw what Bob was doing, several of them offered to buy some of the egg sacs. They wanted to put the egg sacs in their own gardens. They hoped that next summer the mantises would kill harmful insects. Bob's egg sacs were in great demand. He charged 25 cents apiece. Now Bob earns money every fall from his hobby.

To learn how to raise praying mantises, Bob had to observe where the egg sacs were usually found. He looked to see if the female placed sacs on one type of plant rather than another. He tried to find out if the temperature and the rainfall had anything to do with the number of egg sacs he found in any one season. By collecting information, making observations, keeping records, and testing his ideas, Bob is becoming a scientist.

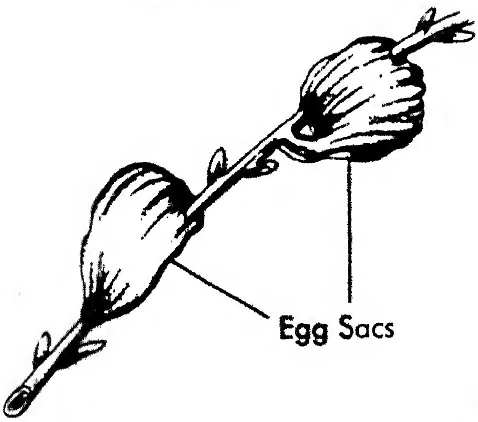
Planning Your Time

You may wonder how to find the time for a hobby. Perhaps your days are so busy with things you must do that it seems impossible to find time for something new. You go to school. You eat. You sleep. You play with friends. You help around the house. You listen to the radio. You watch TV. When is there time for a hobby?

Sometimes a work plan can help you find free time. When you follow such a plan, you know when you should stop one job and start on another. Many people have found that this type of plan helps them get all their jobs done and still have free time.

Try a work plan yourself. See if it helps you find time you didn't know you had.

U. S. D. A.



A praying mantis. The drawing shows egg sacs.

What is your book made of?

What is a piece of cardboard made of?

What is a piece of chalk made of?

What happens when you mix chalk with vinegar?

Why do your skates get rusty?

If you have ever asked many questions like these, maybe **chemistry** is the hobby for you. Chemistry is the study of what things are made of. If you have a chemistry set, you probably call the materials in the different bottles **chemicals.** Maybe you think that chemicals always come in bottles. But to a chemist, everything in the world is made of chemicals. Rocks, trees, cars, ink, toothpaste, soap, your clothes, your book, your skin, your hair, and your shoes are made of chemicals.

Elements

There are certain chemicals from which all others are formed. These chemicals cannot be separated into other chemicals. They are made up of only one chemical. We call these **chemical elements.** Everything is made up of one or more kinds of chemical elements. Iron is an element. Copper is an element. Oxygen is an element. Coal is mainly an element called carbon.

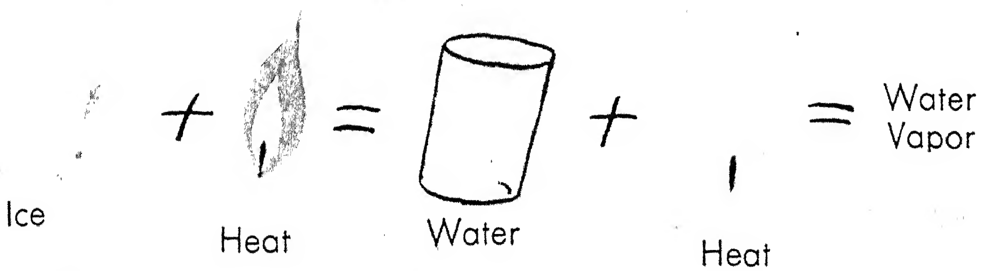
Some of the other elements you have heard of are listed below. Can you tell the ways in which we use them?

sulfur	helium	neon
chlorine	uranium	tin
zinc	aluminum	lead

There are about 100 different elements. These 100 elements make up the air, the earth, and everything on the earth. Baking soda, or sodium bicarbonate, is made of the elements sodium, hydrogen, carbon, and oxygen. Carbon dioxide is made up of the elements carbon and oxygen. Sugar is made up of the elements carbon, hydrogen, and oxygen. Still another combination of the elements carbon, hydrogen, and oxygen makes cotton. Water is made of the elements hydrogen and oxygen.

How Things Change

Some of the things around you never seem to change. The building you live in, the street you walk on, seem to be the same year after year. Yet often things change rapidly. Snow covers the street. When the weather turns warm, the snow melts. The street becomes wet. But soon the street is dry. You light a match, a candle, or a campfire. They flame as they burn. When the material has burned, the flame goes out.



Often the changes you see around you are changes only in the way things look. They are not changes in the elements that the things are made of. When you tear paper, you change the size of the paper. But you don't change the combination of elements the paper is made of. When water freezes, then melts, and finally evaporates, changes have taken place. But the elements in the water are the same. They are together in the same amount. This is true whether the water is ice, liquid, or vapor.

A change in only the form of something is called a physical change. The change in paper when it is torn or in water when it evaporates is a physical change.

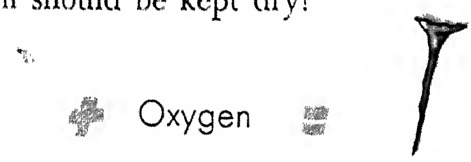
Chemical Changes

Some things change because the elements or combination of elements have been changed. When you see a match or a candle burn, you see such a change. When parts of your bike get rusty, a new element has been added. Whenever the combination of elements in a substance changes, the change is called a **chemical change.**

You have already read that iron is an element. You can find out why your bike gets rusty. Get a nail. Be sure it is made of iron. Some nails are not. Could you use a magnet to find out whether your nail is made of iron? Select a nail that is not already rusty. Wet the nail. Put it on a wet paper towel for several days. Be sure that air can get to it. Turn it from time to time so that the nail stays wet all around. Why will you have to keep putting water on the towel?

After a while, a reddish crust will form on the outside of the nail. If you rub some of this crust off, it will crumble into a powder. This powder is not iron. It is a chemical called iron oxide. It is a combination of iron from the nail with oxygen from the air.

Iron rusts faster when it is moist. Does this explain why things made of iron should be kept dry?



Compare the rust with the iron in a new nail. Of course, it is entirely different. Rust is a combination of the two elements, iron and oxygen. So the change in an iron nail when it combines with oxygen is a chemical change.

Chemical Compounds

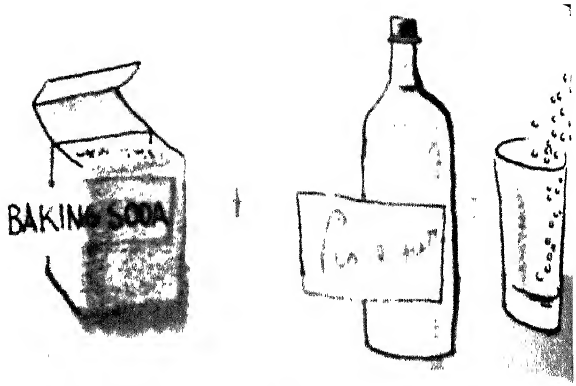
When two or more elements combine to form an entirely different substance, the new substance is called a **compound.** Thus iron oxide, or rust, is a compound. Water is also a compound. It is a compound of hydrogen and oxygen. The material used in making the paper in this book is a compound of carbon, hydrogen, and oxygen. Table salt is a compound of sodium and chlorine.

Compounds do not look or act like the elements they are composed of. Ordinarily, you can't see oxygen or hydrogen. They are gases. Water is a compound of these two gases, and you can see water. Separately, chlorine and sodium are both poisonous. Combined, as they are in table salt, they are not poisonous.

Making Chemical Changes

You can make some chemical changes in your own classroom with chemicals that are easy to get. Put one-fourth teaspoon of baking soda into a tall glass. Pour three tablespoons of vinegar over it. You will see thousands of little bubbles form when these two chemicals mix. The bubbles rise in the glass and even spill over if you don't use a tall enough glass.

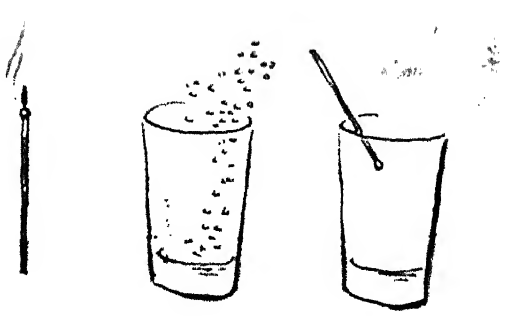
Now let's find out why the bubbles



formed. Baking soda is a chemical compound. In the vinegar is another compound. When these two compounds come together, new compounds are formed. One of these new compounds is a gas called carbon dioxide. Does its name tell you what elements it is made of? We breathe carbon dioxide out when we exhale. Carbon dioxide is found in small amounts in the air all the time.

Chemical changes that produce carbon dioxide are useful. As you may remember, carbon dioxide is a gas often used to put out fires. You can see for yourself how carbon dioxide does this. Make some carbon dioxide in a tall glass. When the bubbles stop forming, carefully lower a burning match into the gas in the glass. You will see the fire go out immediately.

Why did carbon dioxide put out the fire? Carbon dioxide is heavier than air. It pushes the air out of the glass. In an earlier grade you learned that a fire needs the oxygen in air to burn. Carbon dioxide keeps the air, with its oxygen, away from the burning material. The fire goes out because there is not enough oxygen for it.



Chemical Changes in Your Body

All of your bodily activities are brought about by chemical changes going on inside you. Some of these changes take place when you digest food. Chemicals in your mouth and stomach mix with the foods you eat. Both chemical and physical changes take place in the food. After these changes, the food can be used by your body. The food is carried by your blood to each cell in your body. Some of the food is used to make new cells. Energy from the food produces heat. This energy also makes it possible for you to move, think, and stay alive.

One important chemical change takes place when you chew bread or potatoes. You probably know that bread and potatoes are mostly starch. Since starch does not dissolve in water, it cannot pass through the lining of your intestines into your blood. But sugar does dissolve in water. When you eat starch, chemicals in your saliva and in your intestines change the starch to sugar. Now the dissolved sugar can pass through the lining of your intestines and into your blood.

Some Chemistry Experiments

Here are a few chemical experiments that will give you more of an idea of what the hobby of chemistry is like. You can get the chemicals in a drug store.

One experiment you can try makes cloth fire retardant. A fire retardant cloth will not flame up like an ordinary one. Curtains and pot-holders are sometimes made fire retardant. Perhaps you will want to make a few things fire retardant after you have done this experiment.

You will need a chemical called ammonium chloride. You will also need a pint of water and a large jar to hold the water. Dissolve three tablespoonfuls of ammonium chloride in the water. Stir until all the ammonium chloride is dissolved. You now have the fire retardant mixture.

Next, take a clean, dry cloth and tear it in two. Dip one piece into the mixture. Then let it dry. This may take a day or two. When the cloth is dry, hang both pieces of cloth over a metal basin. Try to burn each piece with a match. You will find that the piece that was not dipped will flame up immediately. The other will turn black, but it won't burst into flame for a while.

How does a fire retardant work? When ammonium chloride is heated, a chemical change takes place. Two

A. C. Gilbert Co.

A chemistry set can get you started on an interesting hobby.

gases are produced—ammonia and hydrochloric acid. Things will not burn in these gases as they do in oxygen. Therefore, the cloth does not burst into flame. You can dip any cloth into your mixture. It will stay fire retardant as long as you don't wash out the mixture.

Here is another chemical change you can try. Put a teaspoonful of flour into a small glass. Add a teaspoonful of baking powder. Stir this mixture with enough water to make it pasty. You now have baking dough.

Put a small amount on a spoon and heat it. Soon you will see a chemical change. You will see small bubbles appear on the spoon. These are bubbles of carbon dioxide which came from the baking powder. Now you know what makes a cake rise in the pan when you bake it.

Getting Your Equipment

You can easily get the equipment to do many chemistry experiments. You can use jars and drinking glasses to mix things in. You can use spoons for measuring and candles for heat. You can find chemicals in your mother's kitchen or buy them at a drug store.

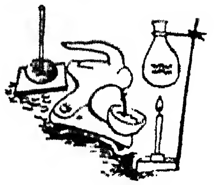
You can also buy chemistry sets. You can do many chemistry experiments with the equipment and chemicals in these sets. Chemistry sets usually contain a book explaining the experiments that can be done with them.

A chemistry set can start you on a chemistry hobby. But, as you become more and more interested, you may want to work with things that aren't in the set. You can buy some of these things and build your chemistry set into a little chemistry laboratory.

When you experiment with chemicals, you must always be careful. A few chemical mixtures are dangerous. Some mixtures produce great heat. Some mixtures explode. Others produce harmful gases. Try only those experiments that are described in books for people your age or that some adult who knows chemistry tells you are safe.

Like all hobbies, chemistry gives you the greatest pleasure when you work at it. To tell whether you will like a hobby, you must give yourself a chance to find out as much about it as you can.

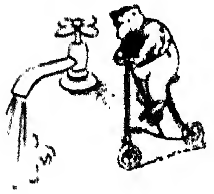
Things to Do



1. Heat a copper wire in a flame. Notice the color before and after. The heat makes the copper combine with oxygen from the air. The new compound that forms is called copper oxide.

2. When silverware is exposed to certain foods and left in the air for long periods of time, it becomes tarnished. It tarnishes because a black compound, silver sulfide, is formed. Here is a chemical method of cleaning silverware. Put the silver on a piece of aluminum foil in a pan. Dissolve half a teaspoon of salt and an equal amount of baking soda in a pint of water. Put the mixture into the pan with the silver. Boil the mixture and let it stand until the silver sulfide is removed. Rinse the silverware. In the chemical change that has taken place, the aluminum foil became tarnished and the silver was left shiny.

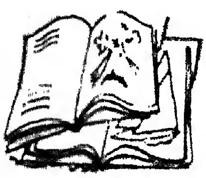
Things to Talk About



1. A green leaf makes food from water and carbon dioxide. Why is this called a chemical change?

2. Sometimes windows seem to "sweat" in the winter. Why is this called a physical change?

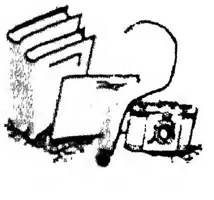
Things to Read About



1. Look up "air" in an encyclopedia. Find out which elements and compounds are most plentiful in air.

2. Which mineral elements are most important in your diet? Review "The Science of Food" to find out. In what compounds are these elements commonly found?

If You Want to Find Out More



1. Thoroughly mix iron and sulfur in a test tube. Heat the mixture. Do these elements combine to form a chemical compound? How can you tell?

2. What chemical change takes place when you take a photograph? Go to an encyclopedia to find out.

Pancakes are fun to make and good to eat.

COOKING AS A HOBBY

We generally think of women and girls as the cooks. But cooking is a hobby that many men and boys also enjoy. Some people make a hobby of cooking only unusual dishes. Some do baking only. Some like to make salads. And there are others who enjoy cooking complete meals as their hobbies.

No matter what kind of cooking you do, there is a great deal of science in it. Foods must be selected. They must be put together in certain amounts. They must be put together in a certain order. Often they must be heated for only a certain length of time. They must be heated to a certain temperature. Sometimes they can be heated only in certain kinds of pans. When you understand why these things are done, you understand the science of cooking.

What Heat Does in Cooking

What does heat do to vegetables? Why do we cook meat?

You have already read that cooking destroys disease germs that might be in some foods. But there are other reasons for cooking foods. Cooking makes some foods softer and easier to digest. It makes some foods taste better, too.

Here is a comparison you can make to show how cooking softens vegetables. Divide any raw vegetable into two portions. Put one portion into a small amount of boiling water and let it cook for about fifteen minutes. You can try string beans, carrots, celery, potatoes, or any other vegetable. Now take some toothpicks and try to separate pieces from both the cooked and uncooked vegetables. How do they compare in toughness?

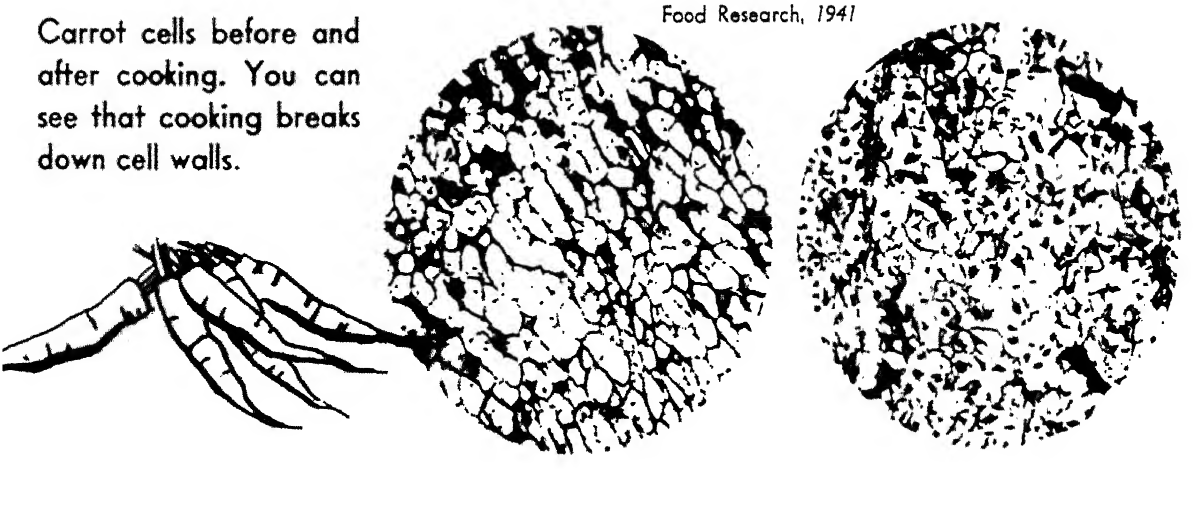
The substance that makes most raw vegetables tough is **cellulose.** Cellulose is the hard material that covers or forms the wall of each cell in a plant. You can see cellulose around the cells containing the juice in an orange or grapefruit. This is the same material that makes up the hard woody part of the roots, trunk, and branches of a tree. In fact, it is the material that was used in making this paper. Cooking softens the cell walls and another substance that holds the cell walls together. The vegetables are then easier to chew and to digest.

Meat is made up mostly of muscle cells. Each muscle cell contains protein and water. When meat is cooked, several things happen. It changes color from deep red to brown or gray. The meat will weigh less because water and fat are cooked out of it. Its flavor will change.

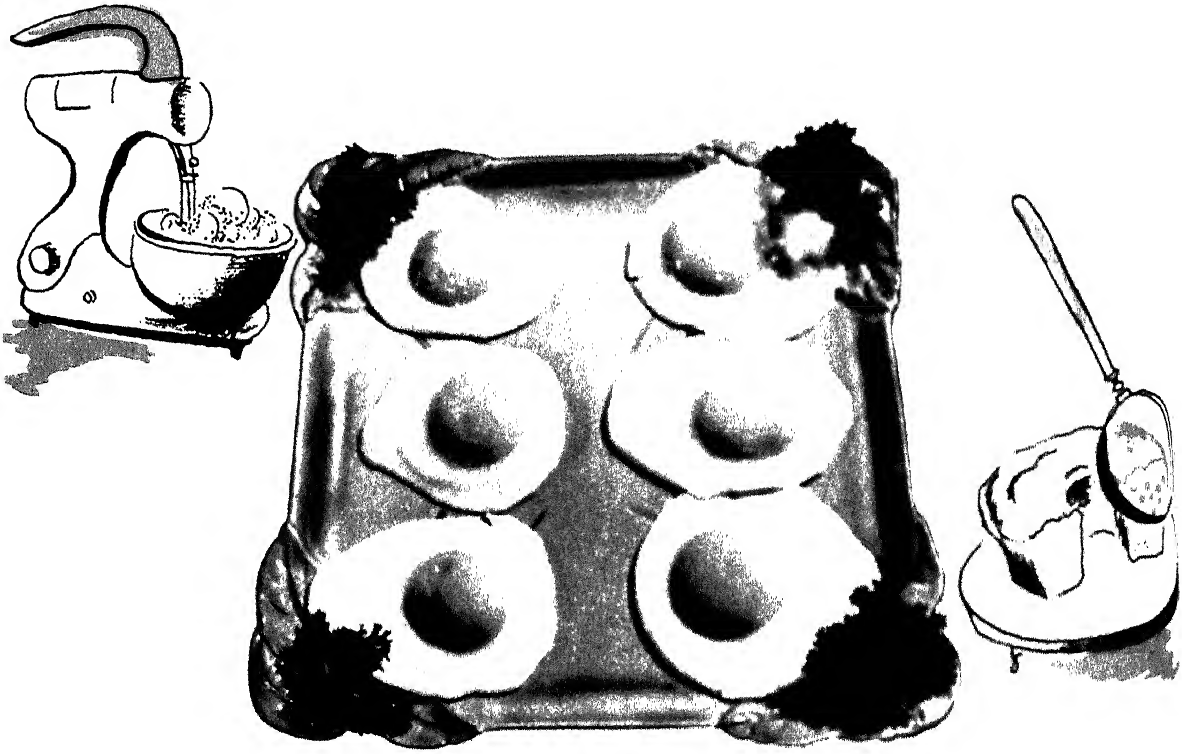
The protein in muscle cells is something like the protein in the white of an egg. You know what happens when the white of an egg is fried or put into boiling water. It gets harder. The same thing happens to protein in meat. The protein becomes harder even though the meat itself becomes more tender.

You can make a comparison to see the difference between raw meat and cooked meat. Cut a thin slice from a piece of raw beef. Now cut the slice into two equal pieces. Heat one piece in a pan or on a hot plate. How can you tell when it is cooked through? After it is cooked through, let it cool. Now compare the color and size of the raw and cooked meat. By feeling each, tell which has more moisture in it. Pull each piece apart. Which one was easier to separate? With toothpicks see if you can separate some of the muscle fibers in each piece. In which piece was it easier? Press a piece of brown paper firmly against each piece. If the paper picks up any fat, there will be a spot on it. It will be different from a water spot. It will not dry. Which piece of meat gave up more fat?

Food Research, *1941*



Carrot cells before and after cooking. You can see that cooking breaks down cell walls.



How has heat changed these eggs? Eggs are not only good to eat in themselves. They are also useful in cooking. Beaten egg whites, for example, give sponginess to cakes.

Why Eggs Are Used in Cooking

Eggs contain protein and other important nutrients. You have seen the protein become firm when an egg is cooked. Perhaps you have noticed that your mother uses eggs when she makes custards and certain pie fillings. When the mixture is heated, the protein in eggs gets harder. This helps to make the custard or pie filling firm.

Eggs are also used in making cakes. When eggs are beaten, they make a fluffy foam. This happens because the protein in the eggs forms thin films around little bubbles of air. The egg foam is then mixed with the other materials to make the cake batter. When the batter is heated, the air bubbles get bigger. They make the cake rise. After the cake rises, the protein film around each bubble becomes firm so that the cake holds its shape. Can you think of some other foods besides cakes where eggs are used for this reason?

Regulating Heat for Cooking

In cooking food, the heat must be regulated. If there is too much or too little heat, the food will not cook properly. Recipes generally tell you at what temperature foods should be cooked. In cooking some things, like candy, you can put a thermometer into the mixture to make sure that it cooks at the proper temperature. In baking, you must use a thermometer to make sure the temperature in the oven is just right. Many gas and electric ovens can be set so that they will stay at a certain temperature. Compare your classroom thermometer with a cooking thermometer. How are they different?

The pans that you use in cooking some foods are also important in regulating heat. Do dull baking pans get hotter than shiny ones? Here is an experiment you can do to find out. Get two cake pans. Get one that is dull and dark from use. Get another bright shiny one. Hold each pan over an electric light bulb. Make sure that each light bulb is the same size. Make sure that they are the same distance from each pan. Put a piece of butter in the center of each pan. Each piece of butter should be the same size. Now turn on the bulbs at the same time. In which pan does the butter melt first? In which pan would a cake be more likely to burn?

Saving Minerals and Vitamins

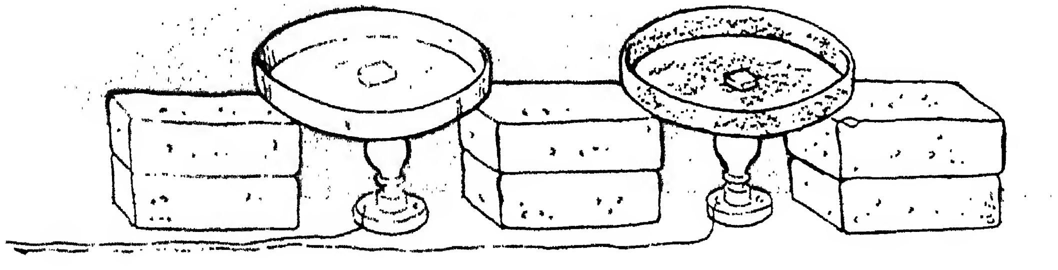
Anyone who cooks wants people to enjoy the food he prepares. He should also want people to get the proper nutrients from the food. But sometimes the way a food is cooked makes it lose many of its vitamins and minerals.

Minerals dissolve in water. When you cook vegetables in water and then throw the water away, you lose some of the minerals. Some vitamins also dissolve in water, and they, too, are lost when the cooking water is thrown away. Other vitamins dissolve in fat. When the fat is removed in cooking, some of these vitamins go with it. One very important vitamin, vitamin C, is destroyed when the foods containing it are cooked.

The following suggestions will help you save minerals and vitamins when you cook vegetables.

1. Cook them in as little water as possible.
2. Cook them only until they are soft enough to eat.
3. Make use of the cooking water.

Can you explain how each of these will help to save minerals and vitamins?



Outdoor Cooking

Some people say that food never tastes better than when it is cooked outdoors. Do you agree? A hot dog roasted over an outdoor fire can be delicious. So can hamburgers and steaks. Some outdoor cooks claim that their corn on the cob is better than any prepared in the kitchen. Have you eaten other foods that were cooked outdoors?

Charcoal is a fuel that is often used for cooking outdoors. It is a good fuel because it gets very hot and burns without making much smoke. Charcoal is made from wood, in special ovens. Wood is made up mostly of carbon, hydrogen, and oxygen. The wood is heated with only a small amount of air present. Instead of burning up, the wood loses only its hydrogen and oxygen. Like coal, charcoal is mostly carbon. Often it is pressed into hard pieces all the same size.

You can make a small amount of charcoal by heating small bits of wood in a test tube. Use a stopper with as small an opening as you can find. You need an opening to permit the heated air to get out. Other gases are produced when the wood is heated. They must get out too. If the opening is too big, air will get in. Then the wood will burn up instead of turning to charcoal.

Understanding a Recipe

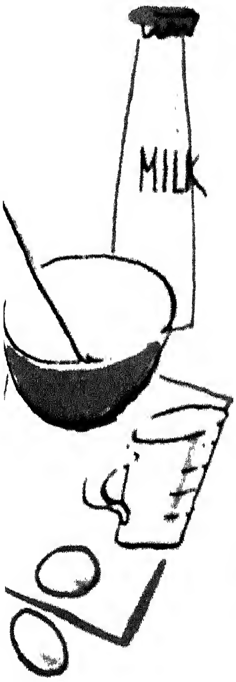
Most cooks use recipes to know what food materials they must use and how much of each kind must be used. We call these food materials the **ingredients.** An ingredient is something that goes into a mixture.

Each ingredient in a recipe is there for a particular purpose. Some boys and girls find this out the hard way. They make cookies without salt, only to find that the delicious-looking products taste flat. Or they forget to put baking powder in the cake and it never rises.

You know already what some of the ingredients in a cake do. You know what eggs and baking powder do. But what does flour do in a cake? Flour contains starch, an important nutrient. In a mixture with other ingredients, starch absorbs water and holds the other ingredients together. Flour also contains a substance called gluten, which absorbs water. Gluten forms an elastic substance. This substance stretches when the bread or cake rises. If you have ever made flour paste, you know how it stretches. You also know how sticky it gets.

You know why cake and cooky recipes call for sugar. Sugar makes the cake or cookies taste sweet. It also affects the appearance of the cake. Too little sugar makes a cake look and feel like bread. Too much makes the cake grainy.

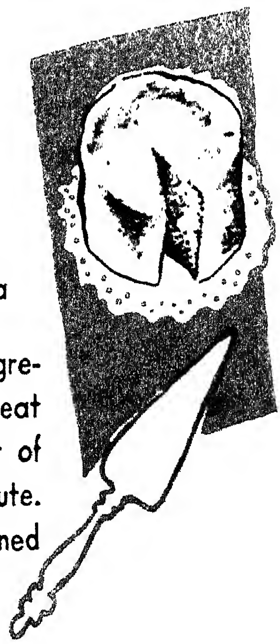
In addition to supplying nutrients, milk is used to give moisture to the cake. Shortening is a type of fat. It makes the dough less sticky. It also holds moisture in the cake. Without shortening, a cake would soon dry out.



A SIMPLE CAKE

1/4 cup soft shortening	3/4 cup sugar
1 1/4 cups sifted flour	1/2 cup milk
2 teaspoons baking powder	1 egg
1/2 teaspoon salt	1 teaspoon vanilla

Put the shortening into mixing bowl. Sift dry ingredients into bowl. Add half the milk. Mix, and then beat until batter is smooth, about 1 minute. Add rest of milk, egg, and vanilla. Mix and beat for one minute. Bake for about 30 minutes at 350°, in 8-inch pan lined with waxed paper.



When baking powder is heated, it gives off carbon dioxide. The carbon dioxide bubbles produced in the dough make the cake rise.

The small amount of salt in the recipe increases the flavor. It also makes the beaten egg stiffer and foamier.

Each ingredient has its special use in a recipe. Some are necessary to make the food look and feel the way it should. Others add flavor. Everything that happens in a cake can be explained. Science helps us do this.

Planning for Cooking

You have seen how cooking can be a science hobby. You can try new ingredients. You can experiment with different ways of mixing the ingredients. You can try different ways of heating your mixes. But perhaps more than any other hobby, cooking takes careful planning.

Before you start cooking, you must have all your ingredients in the correct amounts. You must have your pots and pans ready. You must be sure that the food will be cooked at exactly the time people want to eat it.

Pity the cook who is in the middle of mixing the ingredients for a cake and discovers he is all out of flour. Or imagine the beginner who starts to pop popcorn and finds he has no salt. You must have everything ready before you start to cook.

If you are interested in cooking as a hobby, you will have to get still more information. You will probably want to look at many cookbooks, talk with people who do lots of cooking, study science books for facts about nutrients, and try many new recipes yourself. Cooking is a hobby that can lead to very interesting work when you grow up.

Some young people who make cooking a hobby go on to specialize in the science of food in college. They must study science to prepare themselves for work as food specialists. Can you tell, now, why chemistry, for example, is so necessary for food specialists?

Things to Do

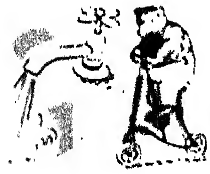
1. Make a collection of favorite recipes. Perhaps you can try a few of them in class.

2. Plan a cook-out for your class. What foods can you easily prepare outdoors? What kind of a fire will you have? How will it be kept? Who will buy the food? Who will plan how much to buy? Who will serve? Who will bring the forks? Who will clean up?

3. See if a group of your friends can tell the difference between a frankfurter cooked over a charcoal fire and one broiled in an oven. How could you do this to make sure that your friends did not know how the frankfurters had been prepared before they tasted them?

4. Take two potatoes about the same size. Bake one wrapped in metal foil. Bake the other without any wrapping. Do they taste the same? Does it take the same length of time to bake each one?

Things to Talk About



1. What should you do to the flame once the cooking water for vegetables starts to boil? Why?

2. Tough meats should be cooked slowly and by moist heat (stewing, simmering) rather than dry heat (roasting, broiling). Why?

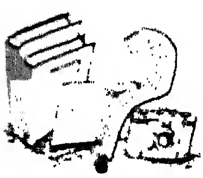
Things to Read About

1. What is the difference between these methods of cooking: boiling, broiling, simmering, steaming, baking, frying?

2. How is cheese made? What makes the holes in Swiss cheese?

3. Cereals are the seeds of grasses. Each cereal grain has certain parts. What are these parts? What nutrients do they furnish?

If You Want to Find Out More



Make a cake batter with four tablespoonfuls of flour, two tablespoonfuls of water, one-eighth teaspoonful of baking powder, and a tablespoonful of melted butter. Bake it. Now make the batter without the butter. Bake it and notice the difference. Make the same batter, but this time leave out a different ingredient. Compare the three. How are they alike? How are they different?

ROCK COLLECTING

You can find rocks no matter where you live. You can start a hobby of rock collecting without leaving your own neighborhood.

Rocks are the solid stuff of the earth. They are made up usually of two or more minerals. Minerals are chemicals found on the earth and in the earth. Up to this point, the only minerals you have read about are nutrients. Food scientists are interested in only those minerals found in foods. Salt is a mineral. The chemical compounds from which we get iron and copper are minerals. But there are many other minerals. There are more than 2,000 minerals. Each kind of rock is made up of a different group of minerals. For example, granite is a mixture of three minerals—quartz, mica, and feldspar.

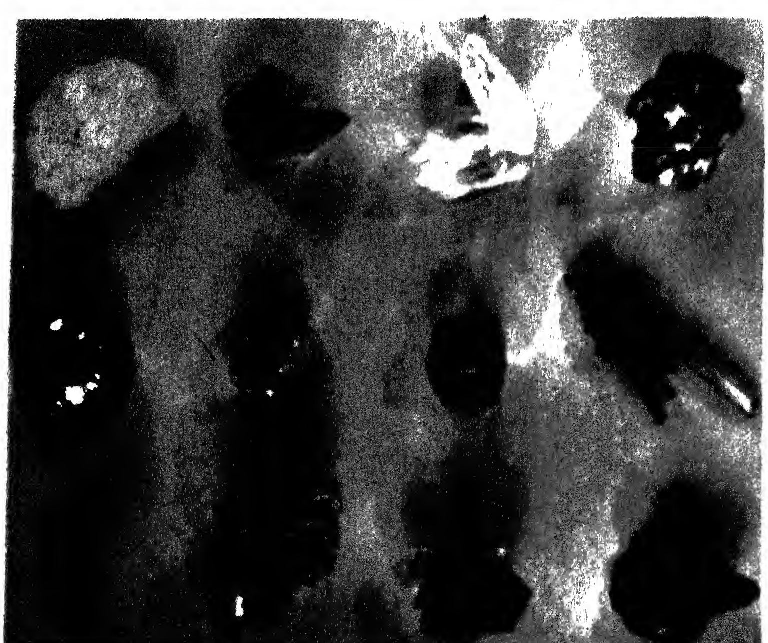
Some minerals are made up of only one element. Sulfur, for example, is an element, not a compound. But quartz, another mineral, is a compound of two chemical elements—oxygen and silicon.

Most minerals are found in the form of **crystals**. Some of the crystals are big. Some are so small you can see them only through a microscope. Mineral crystals have many shapes.

You can make some crystals of sulfur. Heat a small amount of sulfur in a test tube until the sulfur melts. Heat it only long enough to melt it. Pour some of the melted sulfur onto a crumpled piece of paper towel. Set it aside to cool. Needle-shaped crystals begin to form as soon as the sulfur cools. Examine them with a hand lens.

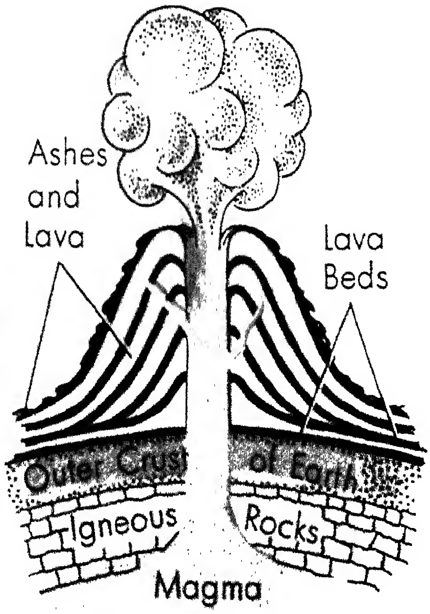
Since rocks are made up of minerals and most minerals are in the form of crystals, there are crystals in rocks. You can see these crystals more plainly when you crack rocks open.

American Museum of Natural History



Mineral crystals from many parts of the world

American Museum of Natural History



Mt. Lassen, California, as it looked when it erupted in 1914. The drawing shows the inside of a volcano.

Rocks From the Hot Earth

Scientists believe that the earth and other planets came from the same material as the sun. Some believe that millions of years ago the whole earth was very hot. It was so hot that everything was a gas. Then the earth began to cool. You know what happens to gases like water vapor when they are cooled. They change to liquids. As the earth cooled, the hot gases changed to a heavy liquid, called **magma**. The magma contained many different minerals. As the earth cooled further, the magma became solid rock. Rocks like granite were formed in this way. They are called **igneous** rock, which means "fire-formed."

Rocks are being formed in this way today. Several miles below the outer hard rock crust of the earth, there is magma. Whenever there is a deep crack through the hard rock of the earth, the magma is forced out to the surface. Sometimes the magma forces its way to the surface through weak spots in the hard rock above it. This is what happens when a volcano erupts. The magma that flows out of a volcano is called **lava**. Sometimes the magma cools before it reaches the surface. When this happens, igneous rock is formed below the surface of the earth.

Rocks That Water Helped to Form

As magma on the surface of the earth cooled, deep wrinkles formed. You can see this happen with a baked apple. As the apple cools, its skin wrinkles in places. When this happened on the earth, mountains and valleys were formed. The earth was a wrinkled mass of igneous rocks. There were no plants, no animals, no soil—

just water and mountains of igneous rocks. As rains fell, small streams of water ran down the mountains of rock. The water slowly washed away particles of rock and wore ridges in the mountains.

Igneous rocks were broken down in another way, too. Here's something you can do to see how it happened. Fill a small screw-cap bottle to the brim with water. Screw on the cap. Wrap the bottle in a rag and place it in the freezing compartment of a refrigerator or outdoors on a day when the temperature is well below 32°F. Leave the bottle there until the water freezes. What happens to the bottle? When water fills the tiny cracks in a rock and then freezes, it cracks the rock—just as freezing water cracks the glass bottle. The smaller pieces of rock are then washed away when the ice melts.

The streams of water carried the pieces of rock to oceans, where they settled to the bottom. We call these materials that settled to the bottom **sediment.**

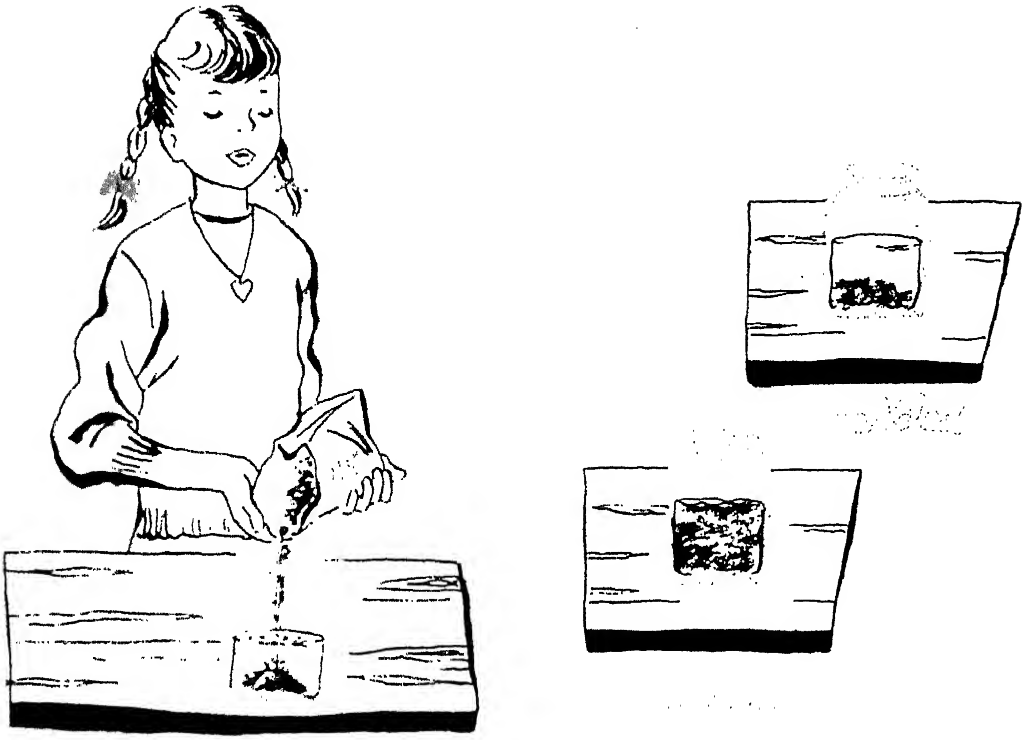
Slowly the sediment built up. Over millions of years the sediment became deeper and deeper. The great weight of the upper layers pushed with great force on the lower layers. The tiny rock particles were pressed together to form a solid mass of rock. Such rock is called **sedimentary** rock. Why is this a good name for it? Sandstone is sedimentary rock formed from sand. Shale is sedimentary rock formed from mud.

Here are two activities you can try to show how sedimentary rock is formed. For one, gather soil and pebbles and place them in a tall jar half filled with water. Cover the jar and shake the mixture. Sediment will form at the bottom after several hours.

For the second activity, take some wet soil in your hand. Squeeze it as tightly as you can by making a fist. Notice how much harder the material becomes when the water has been pressed out.

Sedimentary rocks were formed in another way, too. In the oceans of the earth there are millions and millions of tiny animals that have hard coverings around their bodies. These coverings contain minerals taken from sea water. When the animals die, their coverings settle to the bottom as sediment. Over millions of years layers of this kind of sediment have built up and formed another kind of sedimentary rock. A sedimentary rock called limestone was formed in this way.

Much sedimentary rock is found in mountains, far from any ocean. How did it get there? Over millions of years, material has been worn away from higher places and carried down to lower places on the earth. The weight of this has caused the earth's crust to



Florida State News Bureau

Castillo de San Marcos in Florida. Early settlers began building this fortress in 1672. It is made of coquina, a kind of limestone formed from the shells of tiny animals.

crack and change shape. When this happens, we have earthquakes. At times the earth's crust shifted with such force that mountains were pushed up where oceans used to be. Many islands in the South Pacific were formed this way.

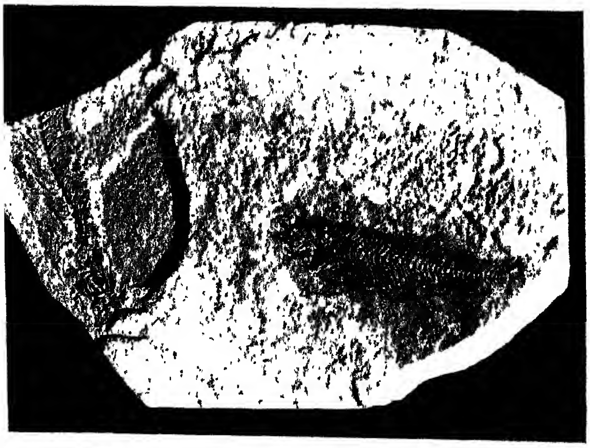
There is more sedimentary rock at the earth's surface than any other type. In some places, it is more than five miles deep. Below the sedimentary rock is igneous rock. Below that is magma.

You can usually recognize sedimentary rock by its layers. Sometimes you need a hand lens to see the layers. The layers will be slightly different in color or thickness in most sedimentary rocks. In the picture you can see clearly the separate layers in sandstone.

The prints of plants or animals that died millions of years ago are often found in sedimentary rock. Sometimes

A fossil fish, embedded in a rock found in Kansas. This small fish lived millions of years ago.

American Museum of Natural History



A huge sandstone formation in Zion National Park, Utah

the shell or bones of an animal can be found, too. These signs of ancient life are called **fossils**. From fossils we are able to tell what kinds of plants and animals existed in the past. If rock collecting becomes your hobby, perhaps you can find sedimentary rocks containing different kinds of fossils.

Rocks Are Changed

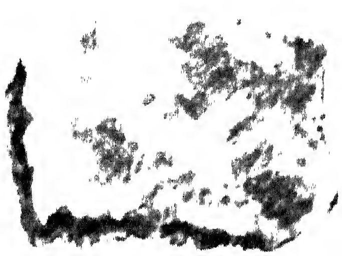
Some sedimentary and igneous rocks have been changed by heat and pressure beneath the earth's surface to a different kind of rock. Rock changed in this way from other kinds of rock is called **metamorphic** rock. *Metamorphic* means "changed form." Marble is a metamorphic rock. It was once limestone. Great heat and pressure changed the limestone into marble. Slate is also a metamorphic rock. It was formed from shale.

Recognizing Different Kinds of Rock

There are hundreds of different kinds of rocks, and no one will know the names of all of them when he first starts a collection. In fact, most collectors begin just by seeing how many different types of rocks they can find. After they have collected several dozen different rocks, they try to name them.

The best way for you to find the name of a particular rock is to compare it with the rocks in a collection made by an expert. Some schools have a large rock collection in which each rock has been carefully labeled. If your school has a rock collection, try to find a rock that looks like yours. The rock in the school collection will probably be shaped differently from yours. But it will be similar in other ways.

If there is not a good rock collection in your school or a nearby museum,



Limestone

Shale

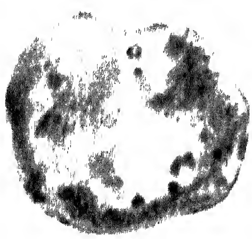
Quartz

Gypsum

Porphyry

Diorite

Basalt



Pumice

Granite

Red Slate

Alinari Photo

Left: This statue of the Greek goddess Diana, in the Louvre museum in Paris, is about two thousand years old. *Below:* A marble quarry in Tennessee. Marble, which is both strong and beautiful, has always been a favorite material of sculptors. What other uses of marble can you name?

Tennessee Conservation Department

look in a book about rocks for a picture of a rock that looks like yours. A book with color pictures is best. Some encyclopedias have good pictures. The pictures of rocks in this book may help you, too.

Some rocks in your collection may look alike when you first find them. All may have the same dull, muddy color. But don't be fooled. Scrub them with soapy water and rinse them well. Then you can see how different their colors are.

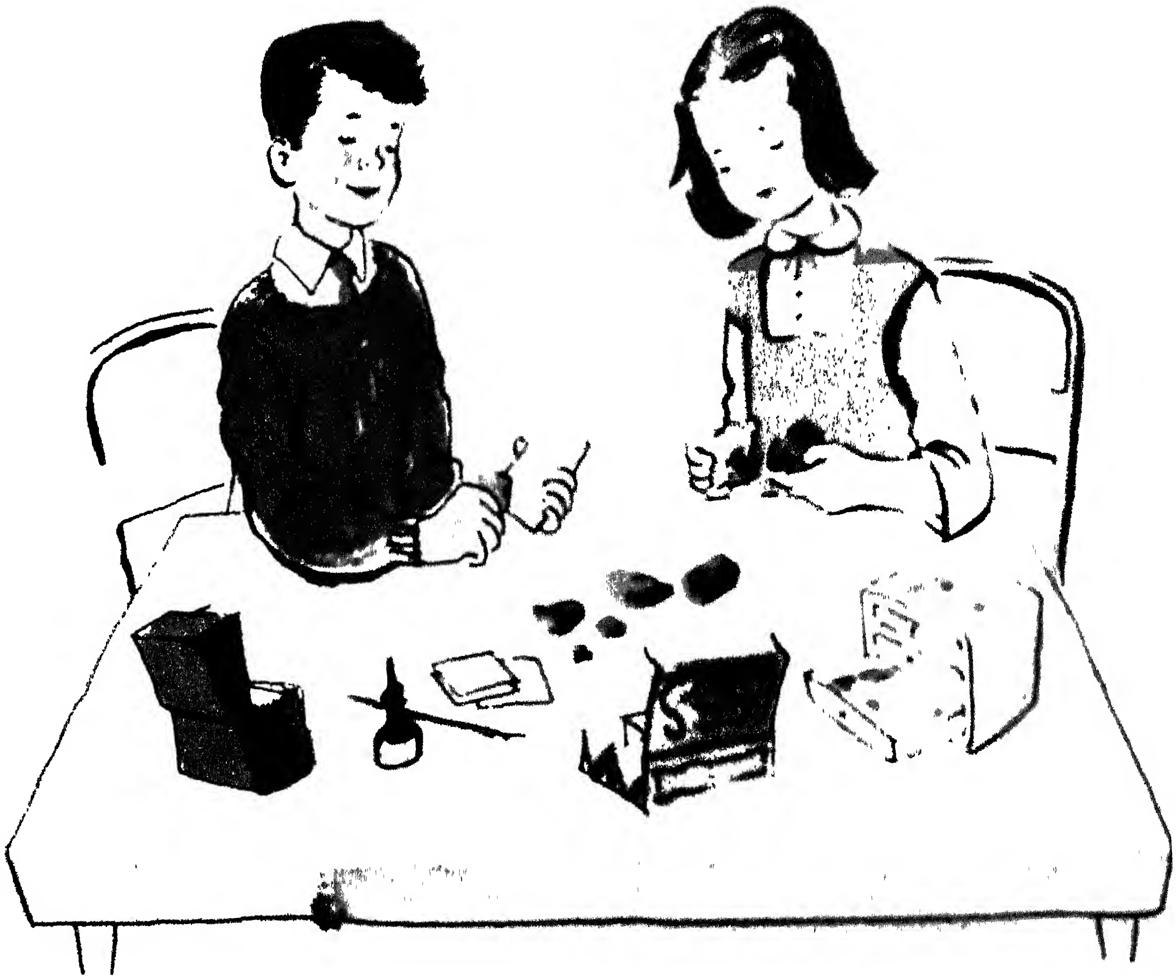
Sometimes even a careful cleaning doesn't give you a good idea of what a rock looks like. The rock may have been exposed to air, rain, and sun for so long that the outside of it is very dull. If this is the case, you can find out more about its appearance by breaking it open. You can do this by putting the rock on some very firm surface and hitting it with a hammer. Be sure to wrap an old rag around the rock first. This will keep the rock chips from hitting you.

Tests to Identify Rocks

When a scientist tries to identify a rock, he often uses special tests. There are chemical tests for marble or limestone, for example. A few drops of acid will make small bubbles appear on these rocks. A scientist out collecting rocks often carries a kit containing a small bottle of acid for this test. You can use vinegar for this test. Vinegar contains an acid.

A magnet helps you identify rocks with a large amount of iron in them. A piece of white tile is used to see what color mark a rock will make when scratched on it. A rock may seem to be a certain color, but when you rub it on a piece of white tile, the color of the mark may be somewhat different. Some books tell you the kinds of marks made by certain rocks.

A collector will also test rocks for hardness. He compares the rock with other rocks. A rock is harder than any rock which it can scratch.



Arranging Your Collection

A rock collection that is kept in special containers and carefully labeled is easiest to use. Plastic boxes and egg cartons make good containers. Probably the best way to label a rock is to paint a white dot on it with enamel. When it dries, put a number on the dot with pen dipped in India ink.

For each rock in your collection, keep a card with that rock's number on it. The card might contain the name of the rock (if you know it), where the rock was found, the date it was found, and the tests you used to identify it.

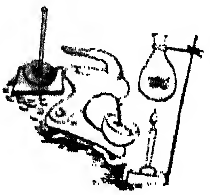
You will also want to use some system of arranging your collection. Which rocks will you keep together? Here are a few different ways a rock collection can be arranged.

1. By color.
2. By the way the rocks were formed (igneous, sedimentary, or metamorphic).
3. By hardness.

Can you think of any other interesting methods of arranging your rock collection?

As you find out more and more about rocks, you will want to learn new tests for identifying them. You will want to find out still more about different kinds of rocks. You will want to find out more about the chemistry of rocks. A library or a rock collector in your neighborhood may have some helpful books about rocks.

Things to Do



1. How many different kinds of rocks can you find on top of the ground in your own community? Are most of them sedimentary?

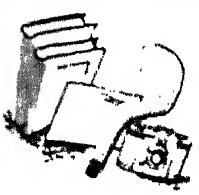
2. What types of rock are found under the ground in your community? Visit a place where workmen have dug a deep hole—perhaps for a building foundation—to find out. If the material has been piled nearby, perhaps you can look for rocks in it.

Things to Read About

1. Look up *fossils* in an encyclopedia. Give a report on three different ways fossils are formed.

2. Report on great earthquakes and volcanoes. Look up the Tokyo earthquake of 1923, the San Francisco earthquake of 1906, the eruption of the Krakatoa volcano in 1883, the eruption of the Mt. Pelée volcano in 1902, and the eruption of the Mt. Katmai volcano in 1912. Look up earthquakes and volcanoes in an encyclopedia.

If You Want to Find Out More



Which rocks are most common in different sections of your state? There is probably a government agency in your state that can give you this information. Sometimes it is called the Geological Survey. Sometimes it is called the Department of Conservation. Write to this agency for information about the types of rocks in your area.

STUDYING STARS AND PLANETS

Collecting rocks is a hobby that you do with things on the earth. How would you like a hobby that takes you away from the earth? Astronomy is such a hobby. Of course you don't really leave the earth. But the things you study—the moon, planets, and stars—are a long way from it. Maybe that's one reason some people find these things so very interesting.

Use a pair of high-powered field glasses to look at the moon. Get a pic-

ture of the moon that has been taken with a big telescope. Compare what you see through your field glasses with what you see in the picture.

When man takes off in a space ship, he will probably go to the moon first. By using an encyclopedia and other books, find out all you can about the moon. You might prepare an illustrated talk on what the first space travelers will find on the moon. You could also do this for Mars and other planets.

Things to Do

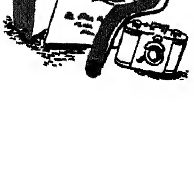
1. Examine children's books on astronomy in your library. Look at the pictures in them. Read the books that look the most interesting.

2. Write to the director of a museum in a large city. Tell him about your interest in getting started with astronomy as a hobby. Ask him for materials that will help you.

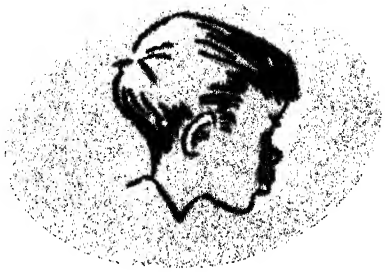
3. Start a collection of star constellations by doing this. Obtain a star map. Carefully read the directions for using the map. Practice arranging it for viewing the sky at different times during the night. After you are sure you know how to use it, begin by finding the Big Dipper in the night sky. Now try locating different constellations. Each time you are sure you have found a constellation, write the name of it in a notebook. See how many constellations you can learn to locate in the night sky. If you can get someone to work with you, it is more fun.

4. Planets are not like stars. They appear in the sky at different times. That's why you won't find them on your star map. Find out if there is anyone in your community who knows how to locate planets. If there is, get him to help you find Venus, Mars, and Jupiter. After you have located them, keep a record of how their position in the sky changes from week to week.

If You Want to Find Out More



If you have a camera, you can take pictures of the moon and stars. On a dark night when the sky is clear, find a place away from street lights. Arrange your camera on a box so that it points toward a part of the sky. Open the shutter of your camera to "Time," and leave it pointed toward the stars for one hour. Now close the shutter. You can continue this for as many pictures as you would like to take. You can make a collection of pictures.



5 *Developing Your Own Personality*

About "*Developing Your Own Personality*

Suppose you wanted to describe a friend to someone. How would you begin?

First, you might describe how your friend looks—how tall he is, what color hair he has, and how he dresses. But does this tell very much about what your friend is really like? Shouldn't you also tell what kind of person he is—how he feels about things and how he acts toward others?

When we say that someone has a lot of personality, we usually mean that he is outstanding in the way he impresses people. Psychologists use the word *personality* differently. Psychologists are scientists who study the way human beings and animals behave. Psychologists say everyone has a personality. If you tell what kind of person your friend is, you will be describing his personality. And just as each of us looks different, each of us has a different personality. In this unit you will find answers to these questions about personality:

Why are people so different in their personalities?

How do we get our personalities?

Can a person change his personality?

YOUR FEELINGS

Ed always seems calm. He doesn't get excited about things such as losing a ball game or being a little late for his favorite TV program. Ed doesn't talk much, but when you ask him a question, he usually has a good answer. He seems just as happy when he plays alone as when he plays with friends. Yet everyone likes Ed and tries to get him to join in games.

Alice is a little bossy. But she seems to have lots of friends. Her classmates admire her because she knows how to get things done. If there is a party to plan, Alice knows how to do it. And she doesn't seem to get upset easily. Alice has more older friends than most of the other people in her class.

Danny doesn't enjoy rough games. He usually plays by himself, and he has very few friends. He is very quiet. Danny doesn't smile very much. But he is always on time and usually gets good grades in school. He spends a lot of his free time working on his stamp collection.

Betty gets enthusiastic about new projects in class. She likes to listen to other people and get their ideas. She is often chosen to be a leader by her classmates even though she is a little younger than they are.

These short descriptions tell more about Ed, Alice, Danny, and Betty than just how they look. These descriptions tell a few things about their personalities. Of course, all four are alike in many ways. They all like ice cream. They all like TV. They are alike in that they all have the same feelings. Each is embarrassed at times, afraid at times, unhappy at times, jealous at times. But each gets these feelings for different reasons.

Ed is afraid of dogs. Alice, Danny, and Betty are puzzled by Ed's fear since they aren't afraid of dogs. But they have fears of their own. Alice is afraid to get up in front of the class and give a report. Danny is afraid of report cards. Betty is always afraid of catching cold. Everyone is afraid at times.

Another feeling that everyone has at times is jealousy. Just as people sometimes have different reasons for being afraid, they also have different reasons for being jealous. Danny is jealous when a boy hits a home run. Ed isn't jealous about the home run. But he is jealous of his younger brother Tommy. The family and visitors make too much of a fuss over his younger brother to suit Ed.

Learning Feelings

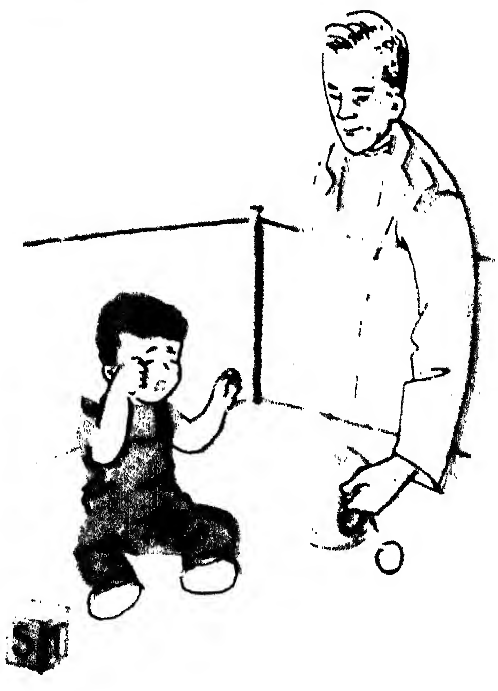
Where do our feelings come from? Why do we differ so much in our feelings about things? Psychologists tell us that we learn these feelings. They have done many experiments to show how feelings are learned. One experiment showed how a child could learn to fear a white rat.

At the start of the experiment, Albert was eleven months old. He played happily with a pet rat. Then the psychologist did this. Whenever the rat was placed near the boy, a steel bar was struck with a hammer. You can imagine what a frightening noise it made. You can probably guess what happened. After only a few times, the baby became very much afraid of the

rat. He started to cry every time the rat came near, even when the loud noise wasn't made!

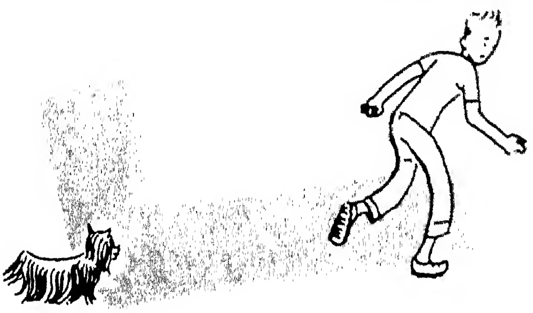
Notice that the rat never harmed the baby. But an unpleasant thing--a loud noise--happened every time the baby saw the rat. He made a connection between the rat and unpleasant noises. He became frightened of the rat.

The psychologist also found that the baby was afraid of all furry objects after this experiment. In fact, when the psychologist came into the baby's room one day wearing a Santa Claus mask, the baby started to cry. He also showed fear of a white muff. He had learned to fear not just the white rat but other things that were like the rat in some way.



Other Types of Fears

You can see from this experiment how people can learn to be afraid of certain things. Ed, you remember, is afraid of dogs. He learned his fear of dogs, although he doesn't remember how or when. A dog may have jumped on him when he was younger. Or perhaps a dog may have bitten one of his friends. Or maybe his mother told him over and over to watch out for dogs.



Danny is afraid when the teacher gives out report cards. He learned that fear, too. He doesn't know that his report card is bad. But he feels uneasy just the same. Perhaps his parents have been strict about other things, and he is always worrying that he may displease them. Perhaps he is afraid he won't get grades as good as his friends get. Now Danny is afraid to get his report card. It isn't just a card with some letters or numbers on it. It's something that is just as frightening to him as a dog is to Ed.

Alice seems to be very calm when she gives a talk before the class. You would never think she is frightened.

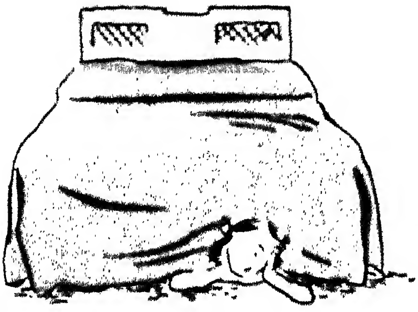
But if you were a good friend of Alice's, you would know that just before she has to get up, her heart pounds, she blushes slightly, and her knees begin to feel wobbly! What do you think Alice is afraid of?

To Alice, it is very important to have her classmates respect her. When she is before the class, she is afraid of doing something that might make everyone laugh at her. She is so afraid of not doing well that she is very shaky inside.

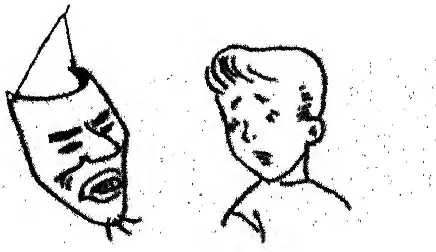
If all of Betty's friends wear loafers, Betty feels uncomfortable wearing tie shoes. She, too, is afraid of being laughed at. Often children are afraid of being different. They try to do things the way most other people do them. They try to wear the same kind of clothes and like the same movie stars that other children do.

As you can see, there are several kinds of fears. Some fears are of real things, like dogs or snakes or thunderstorms. Some of these fears are reasonable. We ought to be afraid of rattlesnakes or copperheads, which are poisonous snakes. But fear of a little garter snake is not reasonable. A garter snake can't harm you.

In the same way there are times when we ought to fear a thunderstorm. Lightning can be dangerous to a person in the water. It can be dangerous to a person standing under a tall tree. But if we are at home during a thunderstorm, hiding under the bed isn't reasonable.



There are other fears children have when there is nothing physical to fear. Have you ever watched a spooky TV show and become afraid? Perhaps you heard funny noises outside your window. Or there might have been a dark shadow in the corner of your room. Or perhaps you were afraid to go to the basement on the errand your mother wanted you to do.



When you become afraid watching a TV show, your fears can carry over to other things. After you turn off the TV, you may think you hear noises or see spooky shadows in your own house. Remember how Albert feared the Santa Claus mask and the fur muff? You, too, learn to fear things that really aren't dangerous in just the same way.

Then there is another kind of fear. This is the fear that your feelings about yourself may be hurt. Everyone needs to feel good about himself. We all need to feel that we are worth while. We may not like to put ourselves in a spot where our feelings about ourselves are in danger. That may be why Alice didn't like to get up in front of the class. This kind of fear may make us do some funny things at times.

There is still another kind of fear. This is the kind of fear we have when we don't know what we are afraid of. Have you ever been worried—but couldn't think what was worrying you? Most people have this kind of fear at times. Psychologists are trying to find out more about it. It is the hardest kind of fear to understand. Psychologists call this kind of fear **anxiety.**

The water snake in the photograph is not poisonous.

Losing Fears

Remember the experiment in which a baby learned to fear a rat? Here's an experiment tried by another psychologist to show how a baby could learn *not* to fear a rat.

Two-year-old Peter was afraid of a white rat. The psychologist wanted to find out how Peter could lose his fear. What do you think she did? What pleasant thing could you have Peter learn to connect with the rat? What could you be sure two-year-olds liked to do? Eat!

While Peter was happily eating, the rat was brought into the room in a cage. Peter stopped eating. The rat was taken out. The next day he continued to eat when the rat was brought in. At first the rat was kept at a distance. Each day it was brought nearer and nearer. Finally, Peter ate lunch with the rat sitting on his tray! He had connected a pleasant experience and the rat.

How can this help you get over being afraid of some things? Would pleasant experiences with a dog help you get over your fear of a dog?

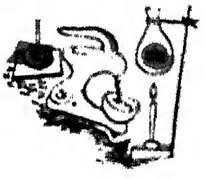
If your younger brother is afraid of the dark, what can you do to help him lose his fear? Do you think it will help to force him to go into a dark room? Does forcing a person to do something he is afraid of help him? Or does it make him even more frightened?

Sometimes people can lose certain fears by learning more about the thing they are afraid of. If a boy is afraid of snakes, for example, it might help him if he learned which snakes are poisonous and which aren't. He might try to have pleasant experiences with some of the harmless snakes by touching them and caring for them as pets. He might gradually lose his fear.

Still another way of losing a fear is to talk about it with a close friend or with your parents. When you talk about fears, you learn that other people have fears just as you do. "Swapping" fears in this way helps you learn that you are not the only one who is afraid. Talking about fears sometimes helps you lose them.

Here's something you can try in class as a way of swapping fears. Draw a picture of something you are afraid of. Have each of your classmates draw a picture, too. Then hang up all the pictures and have every person guess what each picture shows.

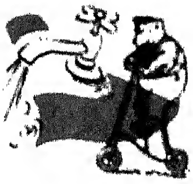
Things to Do



1. Ask different children to act out one of their fears in front of the classroom. See if you can guess each fear that is acted out.

2. A boy is afraid of meeting new people. Have a few people act this fear. Then make suggestions about how the boy might lose his fear of meeting new people. Act out the suggestions, too.

Things to Talk About



1. Do you think children who grow up in other sections of the country or in other neighborhoods from yours have the same fears you have? What does a person's neighborhood or section of the country have to do with the fears he has?

2. Discuss some fears that seem to change as you grow older. Fear of the dark is one that you have read about. Can you think of others?

What does it really mean to feel angry—or to feel afraid or jealous? What happens to your body when you have these feelings? Here are just a few body changes that occur when you are frightened:

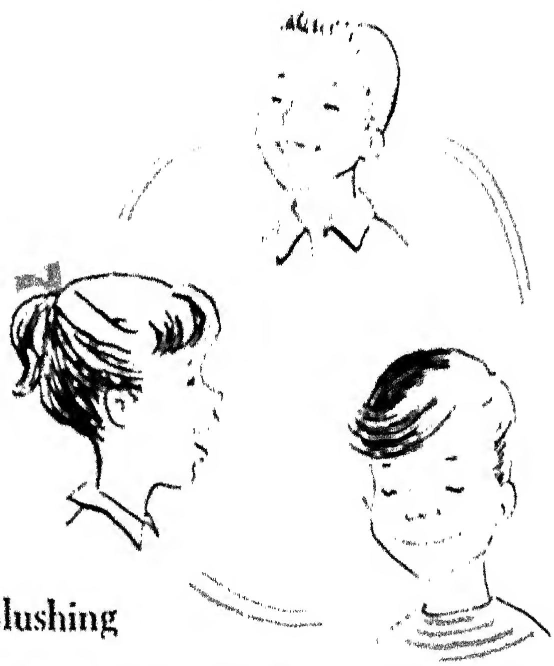
1. You breathe more quickly.
2. You inhale more air than you ordinarily need.
3. Your heart beats harder.
4. Your heart beats more quickly.

These body changes caused by feeling frightened help you meet certain kinds of danger. These changes prepare you to stand and fight or to run, even though you may decide not to do either. Your blood carries more food and oxygen to the cells in the large muscles of your arms and legs. Your muscles are, therefore, ready to do more work. You will not get tired so quickly. More blood rushes to your brain.

With these changes occurring inside your body, you are better able to meet the emergency.

Suppose, as you were crossing the street, that a big truck suddenly appeared; honking loudly. You would be badly frightened. Immediately changes would take place inside your body. These changes would give you extra strength to run if that seemed the best thing to do.

Similar changes happen in Danny's body—although not as strongly—when he gets his report card. But do more food and oxygen in his arm and leg muscles help Danny meet his emergency? Do these body changes help you when you're afraid to take home a poor report card? The body changes caused by fear help you to meet the emergencies where you have to fight, run away, or have extra strength. They are not useful for other kinds of fear.



Blushing

Poor Danny! Look at him blush! The girls are teasing him because he passed a note to Martha. They know he likes Martha a lot. Their teasing embarrasses Danny. And when Danny is embarrassed, he blushes. To make matters worse, they say, "Look at Danny blushing!" And he blushes even more!

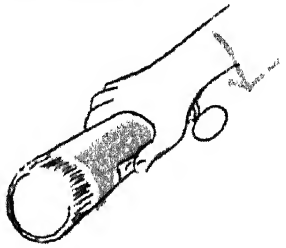
You blush because more blood enters the blood vessels under the outer layer of your skin. This happens because these vessels become larger and your heartbeat becomes stronger. Since the outer layer of your skin is thin, you can see through it and your cheeks look redder.

Ed doesn't blush so easily as Danny for two reasons. First, although Ed gets embarrassed sometimes, he doesn't get embarrassed so easily as Danny. Secondly, Ed has a darker complexion. The outer layer of his skin doesn't permit so much light to pass through as Danny's. Therefore, when Ed's heart sends more blood to the blood vessels in his cheeks, you cannot see it so easily. He doesn't seem to blush so much as Danny. But he may feel just as warm and uncomfortable as Danny.

Here's something you can try to show that light can pass through the skin in your cheeks. Get a small flashlight. Go into a darkened room and hold the flashlight against your cheek. Open your mouth as wide as you can.

Look in a mirror and you will see that a small amount of light comes right through your cheek. You can see the light on the inside of your mouth!

Here's something else you can try. Hold the flashlight against the tip of your finger. Notice that some light passes right through your finger—especially around the edges. Can you find other places on your body where light passes through the skin easily?



Perhaps you have noticed that whenever you are excited, embarrassed, jealous, angry, or scared, you feel funny inside. Maybe you have noticed certain changes in your body—faster heartbeat, more rapid breathing, along with the other changes you have read about. And all people, no matter what makes them excited, feel the same body changes. Of course, the stronger the feelings, the greater the changes that are produced in your body.

Things to Do

1. Find all the places on your body where you can feel your heart beat.

2. Find places on your hands and face that are redder than other places. Why are they redder?

3. What changes does exercise produce in the body? To find out, follow these steps:

   a. Look in a mirror to see how red your face is.
   b. Put your fingers on your chest at the spot where you can feel your heart beat.
   c. Count the number of times you breathe per minute.
   d. Play hard for five minutes. You can run, jump, or skip rope.
   e. Now look in the mirror, feel your heart beating, and count the number of times you breathe per minute.

   What changes do you find?

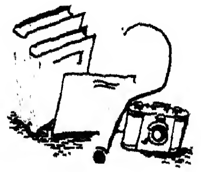
Things to Talk About

1. Have you seen a very young baby? Was it redder than older children? What made it redder?

2. Why do you think your lips look redder than the rest of your face?

3. Have people done unpleasant things to you to try to make you get over a fear? What were they? Did they work?

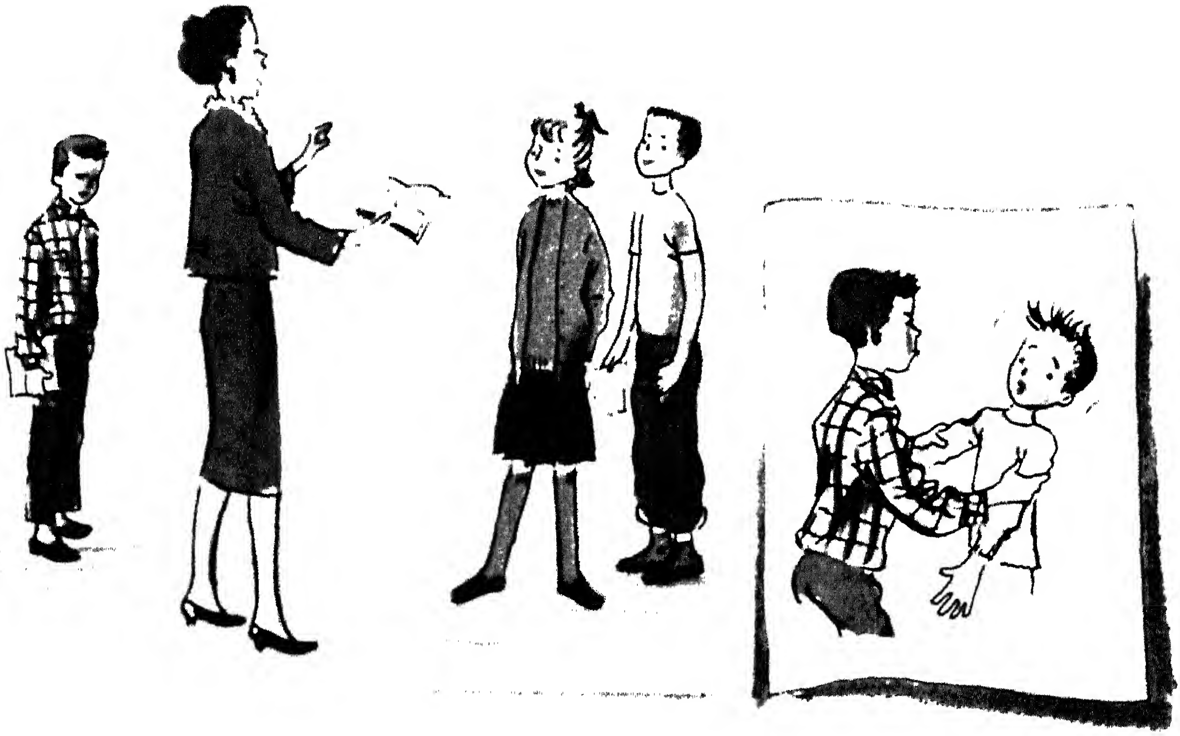
If You Want to Find Out More



Your pulse tells you every time your heart beats. In your wrist there is a large blood vessel that carries blood from your heart to your hand. Every time your heart beats, it forces blood through this blood vessel.

Can you find your pulse? Try counting to see how many times it beats in one minute.

Do all your classmates have the same pulse rate? Do boys have the same pulse rate as girls?



WHAT WE DO ABOUT OUR FEELINGS

Some things will make some people angry while other people will not be bothered by them at all. People have as many reasons for feeling angry as they have for feeling afraid. This is another way in which our personalities are different.

Anger is common. Yet it is one of the most difficult feelings to deal with. It isn't good to keep too many angry feelings inside. But what's a good way to "blow off steam"?

Ben is the boy in the plaid shirt. If you were to see Ben shouting at someone as he is shouting at Tom, it wouldn't surprise you at all. Ben always seems to be getting angry about something.

But look closely at the picture. What really made Ben mad this time? Was it because Tom accidentally pushed him? Or was it because Ben felt left out when the class didn't choose him for the play?

Ben couldn't very well blow up about being left out of the play. He didn't want the class to know it was that important to him. But he had angry feelings inside him. They came out when Tom brushed against him.

It's easy to see this isn't a good way to let off steam. It gets Ben in trouble and it hurts Tom. Taking out our feelings on other people doesn't work.

Here's a different way of letting off steam.

Danny got a poor report card, and he was mad. But Danny knew that he couldn't very well show his anger in school. He had to cover up his anger.

On the way home from school that day, Danny kicked hard at some stones that were in his way. When he got home, he slammed his books down on his desk. He did everything with a great deal of force. This made him feel better. He could let off steam this way. Then he was ready to tackle the problem of how he might improve his school work.

Alice tries to control her feelings a different way. She knows that her little sister didn't mean to break her phonograph record. But she broke it just the same. Alice begins counting to ten! By the time she reaches ten, she hopes the angry feelings inside her will not be so strong. Alice can then talk to her sister more reasonably about not playing with her records. Trying not to blow up immediately helps some people control their tempers. It gives them time to cool off.

All of us have to learn this hard job of controlling feelings of anger. For some children this is a much harder job than for others. They may need special help from a child guidance clinic.

But there are things each of us can do to help. Children who get angry most frequently are often children who really need kindness. Being friendly to these boys and girls may help them. Choosing them for games, not teasing them, and noticing the nice things about them may help.

Trying to understand what caused these feelings may also help. You can watch for what seems to make others angry and avoid such situations. You can also watch for things that make you angry and try to understand them.

If you seem to get angry whenever you play with a certain person, you can try to figure out what bothers you about that person. Then perhaps you can learn to be friends with him. If not, you can try to avoid him. As people grow older, they often learn the things they are "touchy" about. If they can't seem to get over their feelings, they try to avoid the "touchy" situations.

No one can ever cover up his feelings of anger all the time. Adults are still trying to improve their behavior this way. And perhaps there are times when you should show your anger at something that happens. If a younger child is constantly teased, perhaps you should get angry. If someone is treated unfairly, perhaps you should get angry. But as you grow older, you will learn to control how you show your feelings. You will show your anger only about important things. You will try to put your angry feelings to work in useful ways. For example, if you are angry about a law that you think is unfair, you will work to get the law changed.

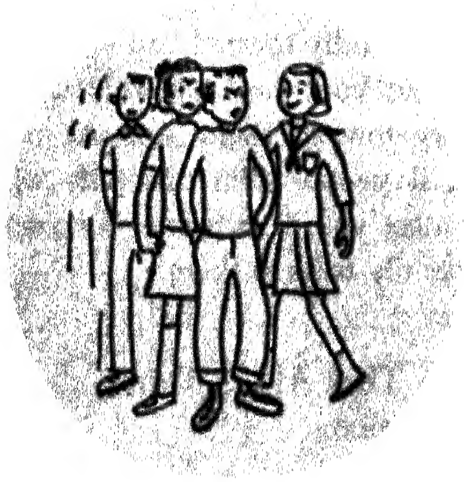
Things to Talk About

1. Some people think you should always control your temper. "Anger never does anyone any good," they say. What do you think? Can you think of any situations where showing your anger does some good?

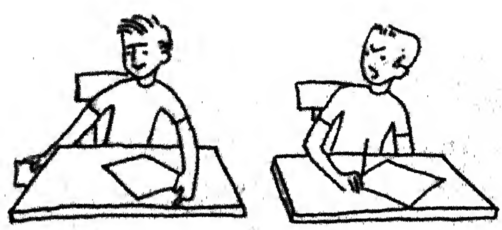
2. Many boys and girls often get angry with their younger brothers or sisters. Interview ten fifth- and sixth-graders who have younger brothers or sisters. Find out what younger brothers or sisters do that bothers the older ones the most. Can you make some guesses as to why children feel bothered by the things their younger brothers or sisters do?

3. Would it make you angry if:

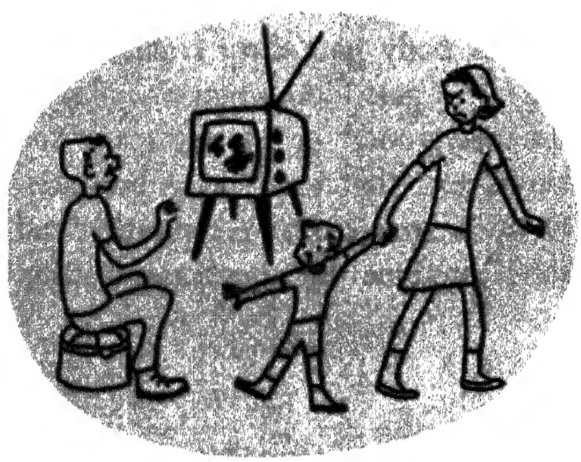
Someone pushed ahead in line.



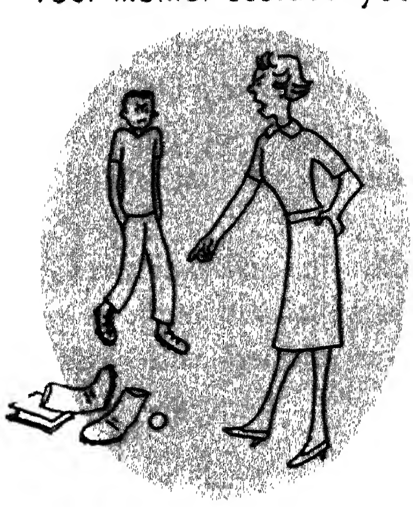
Someone cheated



You couldn't stay up late.



Your mother scolded you.



Perhaps you think it strange to read about appearance in a unit on personality. But appearance and personality are often related.

Part of your personality comes from the way other people act toward you. If they treat you nicely, you learn to have nice feelings about yourself. If they say, "Oh, there's old Beanpole always showing off," you're more likely to show off. If they say, "Look how sweet that Martin girl looks," you're likely to try to act nicely.

Have you ever noticed how grown-ups play with boy babies? They are likely to bounce them around more roughly than they do girls. How does this make the babies behave? Do they get excited and rougher in their play?

Here is one interesting bit of evidence on how appearance influences the way in which people behave toward you. A psychologist and his wife were raising a chimpanzee in their home, just as a human infant would be raised. The chimp, a little female, was dressed in a T-shirt and overalls. She looked very much like a little boy. People always referred to Vicki as a "he," and treated her as they would treat a boy.

One day the psychologist's wife bought Vicki a new outfit—a pretty white dress printed with rosebuds! Now people treated Vicki differently—more gently than they had before. How do you think this might affect Vicki's behavior? What might a little girl do if a grownup said in play, "Come on, boy. Put 'em up. Let's fight!" How might a little girl behave if a grownup said, "What a sweet little girl. How nicely she sits there!"

You can see from the story of Vicki that people may treat others according to their appearance. And the treatment you get from other people helps to determine what you will do. If people are always friendly toward you when they first meet you, you probably will be friendly toward them. On the other hand, if people aren't friendly when they meet you, it is harder for you to be friendly toward them.

Things That Affect Your Appearance

Bathing regularly is the easiest way to keep your whole body clean. And when you keep yourself clean, you look better, and you feel better.

Your body gets dirty from dust in the air. It gets dirty when you play on the playground or in the gym. You know, too, that your body perspires. Bacteria grow in the perspiration and soon produce an unpleasant odor.

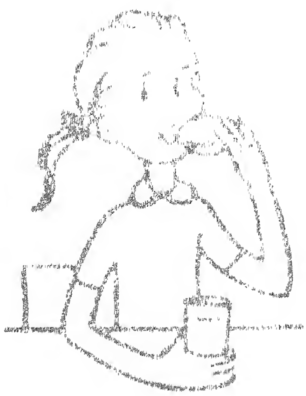
Bathing helps to clean off the perspiration and bacteria as well as the dirt. It helps you get rid of the unpleasant odor.

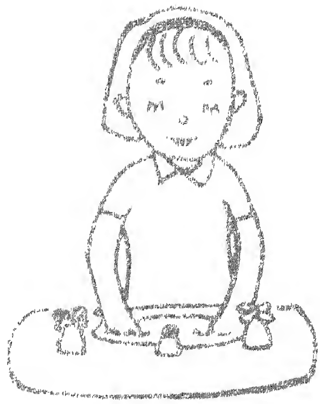
Certain parts of your body, like your ears and between your toes, are harder to clean than others. Yet dirt and wax gather in your ears, and dirt and sweat accumulate between your toes. When you bathe, you need to make a special effort to wash these places. But you should not try to wash or poke anything inside your ear canal.

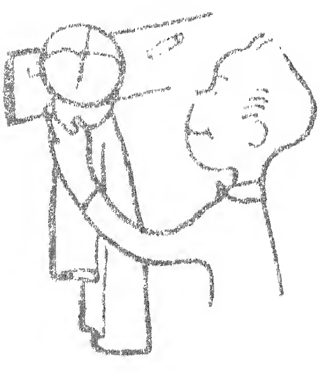
Your clothes, too, add to your appearance. This doesn't mean wearing your best clothes every day. But you can make sure that your everyday clothes are clean and pressed. Hanging up clothes after you wear them helps to make them look fresher for a longer time.

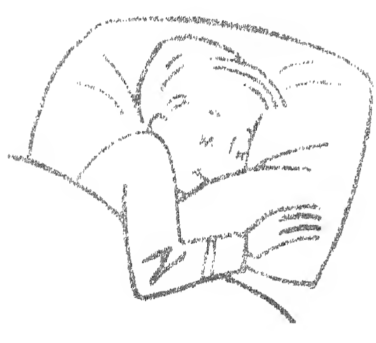
The food you eat and the rest you get also help to determine your appearance. A balanced diet and plenty of rest keep you looking alert and lively. Some vitamins help to keep your skin in good condition.

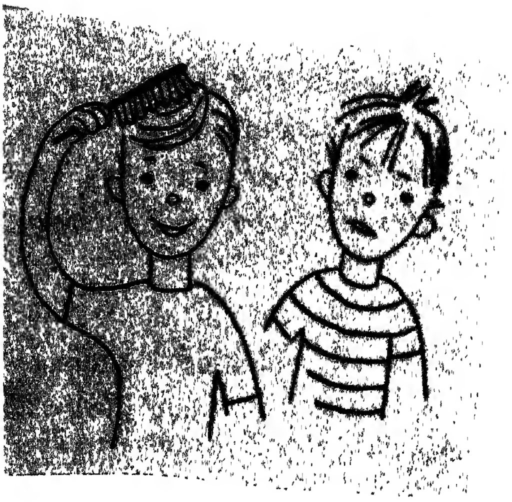
Many things—diet, exercise, clothes, hair, nails, cleanliness—all help to give you a pleasant appearance. And your appearance is an expression of your personality.







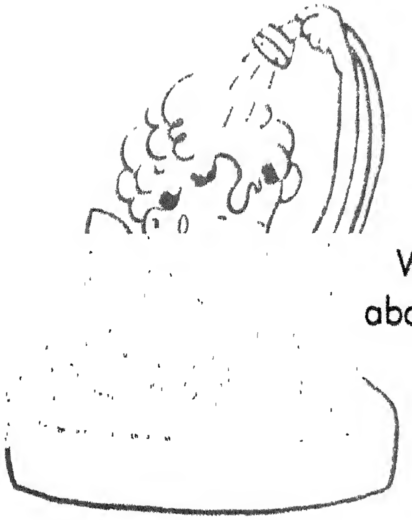




Brush your hair.

Hair and Nails

Your hair and your nails are among the first things a person notices when he looks at you. And both your hair and nails can easily get dirty and need regular care. Here are some things to do to keep these in good order.



Wash your hair about once a week.

Keep your hair neatly trimmed.

Choose a simple style.

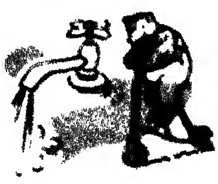
Keep nails trimmed and clean.

Things to Do

1. Soap cleans you by loosening dirt on your body. Try this experiment to show how soap removes dirt. Rub a rag on the floor and make it as dirty all over as you can. Tear the rag in half. Put one half in a bowl of plain water. Put the other half in a bowl of soapy water. Let the rags stay in the bowls about fifteen minutes. Stir them around from time to time. After fifteen minutes remove them and see which rag is cleaner.

2. Is soap effective with all types of dirt? Perhaps you can soil one rag with dust, another with oil, and still another with grease. Compare the effect of soap on each type of dirt.

Things to Talk About

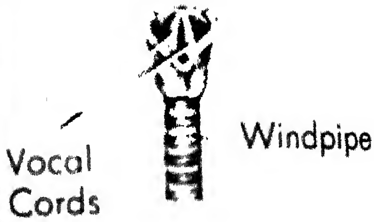


1. Is it usually necessary to bathe more often during the summer than winter? Why?

2. Are you treated differently when you go to the store all dressed up than when you go in the clothes you usually play in? Why?

3. Why shouldn't you judge people just by their appearance?

Chicago Public Schools



In many schools you can get special help for speech problems.

YOUR SPEECH

Just as your appearance is an expression of your personality, your speech is, too. Your voice can be pleasant or unpleasant. Also by taking time to speak carefully, you can be considerate of other people. Speaking carefully shows that you want to make it easier for them to understand you. It shows, too, that you think enough of your own ideas to want to express them in the most careful way.

To understand more fully why some people have difficulties with their speech, let's review first how people use their throat and mouth to talk. Let's review how you make sound waves.

You know that sound waves are caused when an object moves back and forth rapidly. When an object moves back and forth we say it **vibrates.** On a guitar, the strings vibrate and cause sound waves. In a clarinet, the reed in the mouthpiece vibrates and causes sound waves. Whenever a sound wave of any kind is made, something vibrates to cause it.

In your throat there are two thin bands called **vocal cords.** In the drawing you can see where your vocal cords are located. When air from your lungs passes over them, they vibrate and cause sound waves. You can feel your vocal cords vibrating if you put your hand on your throat and then hum.

Now try this. Look in a mirror and say the alphabet. Notice how your tongue, lips, and mouth change positions. These movements change the tone coming from your vocal cords and cause different sounds. If you bring your tongue forward and make the air in your mouth go out over your teeth, you make one kind of sound. If you bring your tongue back and force air out, you make a different sound. All the words you speak are made by the movements of your vocal cords, your tongue, your mouth, and your lips.

Speech Difficulties

Some people have difficulty with their speech. There are people whose teeth do not permit sounds to come out properly. Listen to a child who has just lost his front baby teeth to see how teeth affect speech. There are people whose vocal cords are irritated, the way yours are when you are hoarse. There are still others who were born with the inside of their mouth not formed as it should be. When some of these people speak, much of the sound comes out through their nose rather than through their lips. Their voices sound strange.

People whose vocal cords, mouth, tongue, or lips are not normal almost always have speech difficulties. Such people must have special speech training to learn to make sounds normally. Often doctors can help people with certain speech difficulties by operating on them.

Most speech difficulties are due to other reasons. For example, some people have poor speech because they are nervous or tense. When they get up to speak, they feel uncomfortable. Because they feel uncomfortable, their speech sounds poor. Perhaps they mumble. Or perhaps they stammer. Or perhaps they speak so low you can't even hear them. People with this type of speech difficulty speak poorly because of their feelings.

Sometimes a nervous or tense person can partly lose his speech difficulty by working off his nervousness in some way. Maybe he can lose some of his nervousness by moving around a little while talking, or by using his hands as he talks. Still another way that sometimes helps is for the person to talk while sitting instead of standing.

Many people who are nervous when they speak do this. They take several very deep breaths slowly before speaking. Slow, deep breaths relax you. Then you can speak more easily.

If you really want to improve your speech, you may have to spend many hours practicing. But as you begin to improve, you will probably feel better about yourself.

You have seen that your personality is not a simple thing. In this unit you have read a few examples of how each person's personality is different. But these examples can start you thinking about your own personality. Perhaps these examples will help you understand your own feelings better.

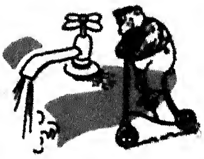
Things to Do

1. Write a description of someone you like in your own class. Don't put down his name or how he looks. Tell only about his personality. See if your classmates can guess who he is.

2. If you have a tape recorder, make a recording of your own voice. Listen to it and see if the recording sounds the way you think you sound.

3. Keep a diary for one week of all the times you get angry. What made you angry each time? What did you do about it?

Things to Talk About



1. Harry, a bright pupil, dislikes arithmetic and does poorly in it. Can you guess the possible causes of Harry's feeling about arithmetic? Use what you have found out about how feelings are learned in your explanation.

2. Why does the pulse rate of an athlete increase before a big game as well as during the game?

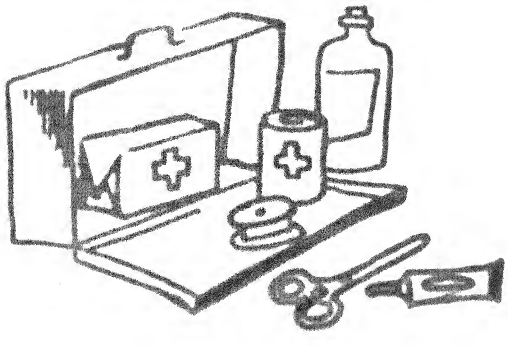
If You Want to Find Out More

See how much you can find out about the personalities of famous people. What made each one famous? How did each get started in his life's work? What problems did they have to work out? Here are some people you might find out about:

Albert Einstein	Florence Nightingale
Abraham Lincoln	Theodore Roosevelt
Wolfgang Mozart	Vincent Van Gogh

See how much you can learn about these people from an encyclopedia. Perhaps you can get a biography of one of these famous people.

6 *What You Can Do About Accidents*



About "What You Can Do About Accidents"

If someone suddenly fainted in your classroom, would you know what to do?

When Nancy fainted in her class one day, most of the children got excited. Some of them had never seen a person faint. They all started talking at once.

BETSY: Let's put her up in her chair.

CATHY: Let her lie on the floor. Don't move her.

EDDIE: Let's get some coats and cover her.

TONY: Put something under her head.

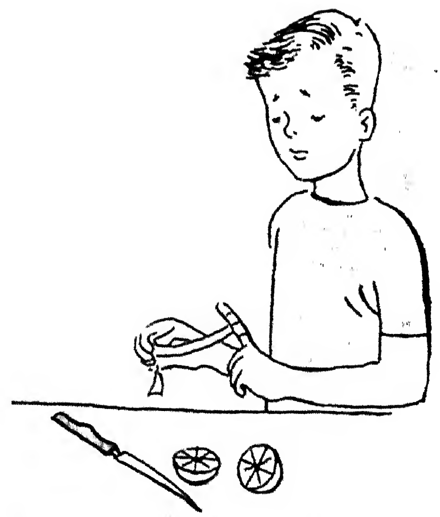
VINCENT: Open the window and let some air in.

MILDRED: Throw a cup of water on her face.

Do you know which of the suggestions would have helped Nancy? Do you know which suggestions may have been harmful?

When someone suddenly becomes ill or has an accident, you can often give help before the doctor arrives. This help is called **first aid**.

In this unit you will learn something about first aid. Then you will be able to help yourself as well as others in case of sudden injury or illness.


FIRST AID FOR WOUNDS

All kinds of accidents happen to people. A boy is stung by a bee. A girl gets a cinder in her eye. A boy cuts himself with a kitchen knife. A baby accidentally swallows poison. Accidents happen every day to thousands of people.

When a serious accident happens, the best thing to do is to send for a doctor right away. Someone who knows first aid may be able to give help before the doctor arrives, but a doctor is always needed to help a seriously injured person.

Once you have called for a doctor, the help you give depends on how the person was injured. First aid for a burn is different from first aid for a cinder in the eye. You help a person with a deep cut one way. You help a person who has fainted another way. First, find out what has happened to the injured person. Then, if you know first aid, you may be able to help him.

Wounds

A **wound** is any injury that causes a break in the skin. The skin might be cut by some sharp object such as a knife. It might be scraped, as it is when you skin your knee on the playground. The skin might be torn by something jagged, like barbed wire. It might be punctured deeply, as it is when you step on a nail. Or it might be scratched open, as it is when you scratch a pimple or a mosquito bite too hard.

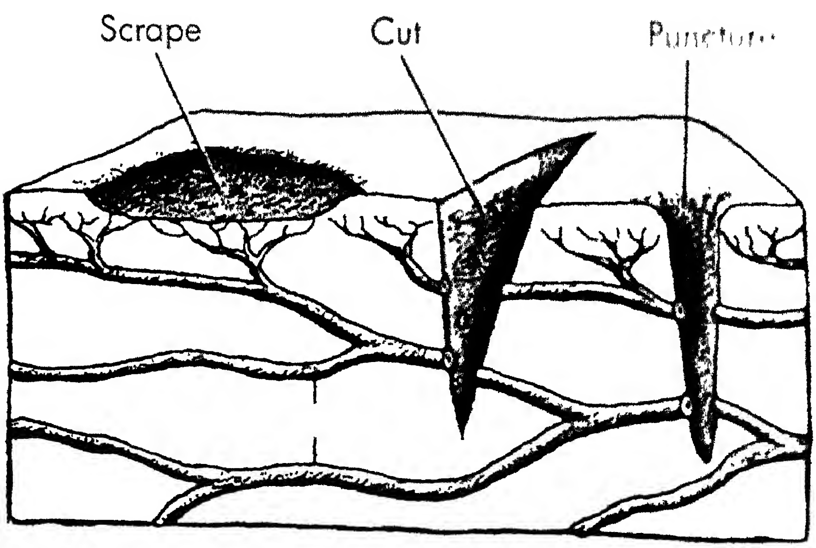
Make a list of the different kinds of wounds you have had lately. Tell how each wound was caused. Compare your list with your classmates' lists. What caused most of the wounds? Does this suggest ways you can be more careful in the future?

Why Are Wounds Dangerous?

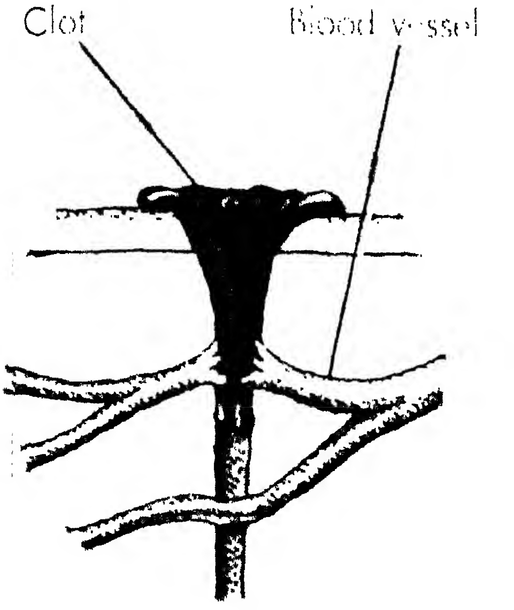
Here is one way wounds can be dangerous. Most wounds bleed. They bleed because blood vessels have been broken open. You know how important blood is. It carries the food and oxygen needed for every cell in the body. A person weighing 140 pounds, for example, has about ten pints of blood. To lose a great deal of blood is dangerous.

But in most cases, bleeding stops before too much blood is lost. Even with very bad wounds you can stop the bleeding if you know first aid. But before we find out how to stop the bleeding, let's see what happens to the blood that comes out of a wound.

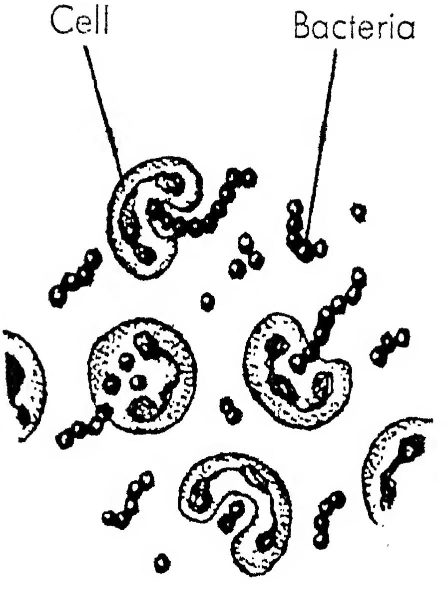
When blood runs out of broken vessels, some of it changes from a liquid to a jelly-like form. We say that the



SECTION OF SKIN



BLOOD CLOT
PLUGGING A WOUND



BLOOD CELLS
ATTACKING BACTERIA

blood clots. This change is something like the change you see when you make gelatin. When liquid gelatin stands for a while in a cool place, it becomes jelly-like.

Some of this clotted blood plugs the breaks in the blood vessels so that no more blood can run out. The rest of it will form a scab over the wound. New skin can grow under this scab. At this very minute you probably have a scab somewhere from a recent wound.

The other way a wound can be dangerous is that harmful bacteria can get into it. You remember that bacteria are tiny plants that can't be seen without a microscope. They are found in the air, in the soil, on the ground, and on everything you touch. There are hundreds of different kinds of bacteria. A few kinds are harmful. A healthy skin is your protection from these harmful bacteria.

When bacteria get into an open wound, the wound becomes **infected.** An infected wound gets red. It may swell and be painful. It turns red because extra blood is carried to the wound. Tiny cells in the blood attack the harmful bacteria.

An infected wound swells because of all the things your body is doing to stop infection and repair the wound. As the wound swells, it presses against the nerve endings that carry the message of pain.

A first-aider should do two things for wounds. He should try to prevent infection and he should try to stop severe bleeding.

Preventing Infection

When you get a scrape, a tear, or a sharp cut, wash it with soap and water right away. Wash carefully around it, too. If the cut isn't very bad, let it bleed a few seconds. The blood will wash out harmful bacteria that may have entered the cut.

Then cover the wound as soon as you can with a **sterile** gauze pad. A sterile pad is one so clean that there are no harmful germs on it. Although air can get through the pad, most of the germs will remain on the outside of the pad. In this way the pad helps protect the wound from infection.

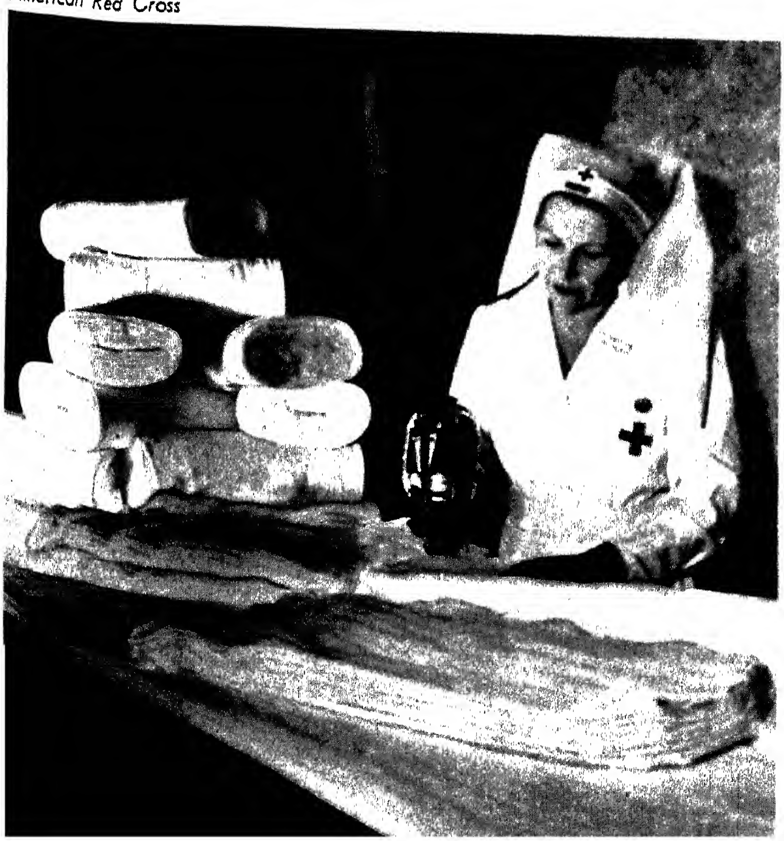
Put a sterile gauze pad on the skin with adhesive tape. Be sure to place the adhesive tape where it touches only uninjured skin.

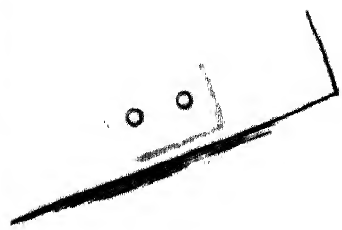
One of the pictures below shows a type of gauze pad you have probably used on small skin breaks. On this type of pad, the cotton gauze is already attached to the tape. Of course this type of pad is too small to cover a large skin injury.

Companies that make gauze pads heat the pads at a very high temperature long enough to kill all germs. Then they seal the pads quickly in sterile paper wrappers. The pads can then be kept for a long time.

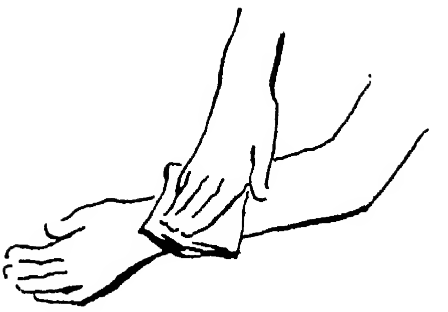
Any covering put on an open wound should be sterile if possible. If you do not have sterile gauze, cover the wound with the cleanest cloth you can find, such as a clean handkerchief or a strip of an old sheet. Most of the germs are killed when laundry is washed and ironed.

American Red Cross





A Red Cross worker cutting gauze for bandages. Supplies must be kept ready for emergencies.



Treating a Puncture Wound

When a wound bleeds, many of the germs that may have entered the wound are washed out. Puncture wounds—such as the ones made by needles or sharp nails—usually bleed very little. If you place a sterile gauze pad over the wound, the pad will stop the bleeding. Any germs that have gone deeply below the skin will remain in the wound.

First aid for a deep puncture wound is to let it bleed some. It may be necessary to press gently around the sides of the wound to force blood out. When you press around the sides of a deep wound, don't touch the wound itself with your hands.

After the wound will no longer bleed, cover it with a bandage. You should see a doctor as soon as possible about a puncture wound, because of the danger of tetanus. Tetanus germs are most likely to be found in the street or in a pasture where there has been horse or cow manure.

How to Make Bleeding Stop

Only in a puncture wound do you try to get the wound to bleed more. The chief danger from some very severe wounds is loss of blood. Although bad bleeding is rare, you should know how to stop it.

One way to stop bad bleeding is to cover the wound with a large gauze pad and press on the pad. Usually this pressure directly on a wound will stop the bleeding. The pressure slows the flow of blood and permits the blood to clot where the blood vessels are broken. Release the gauze pad from time to time to see if the bleeding has stopped. Don't remove the pad, as this may start the bleeding again. If the pad becomes soaked, add another one on top.

If you don't have a gauze pad, and if the wound is bleeding a lot, use any clean cloth. Fold the cloth into a pad and press it over the wound. Even if the cloth is not sterile, use it. In case of bad bleeding, the important thing is to stop it with pressure.

First Aid for Nosebleed

Have you ever had a nosebleed? Some people get one very easily. The nose bleeds when the walls of blood vessels in the upper nose passage break.

Some people may get a nosebleed from being hit on the nose. A few people get a nosebleed by blowing their nose too hard or by sneezing. Others get nosebleeds when they have a cold and their nose is inflamed. Sometimes, the bleeding just seems to start with no noticeable cause.

A few children are troubled by frequent nosebleeds. If you are such a person, you will be happy to know that, as you grow older, you probably will not be bothered so much. People seem to outgrow frequent nosebleeds. But you should ask a doctor about your nosebleeds anyway, so that he can find out the cause.

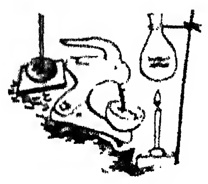
Often a nosebleed will stop soon without your doing anything about it. But if the bleeding does not stop within a few minutes, here's how to give first aid. First, have the person sit up with his head tilted slightly forward. If he is wearing a tie or anything else tight around his neck, loosen it.

Usually the blood comes from one nostril only. After the person is seated, press against the side of the nostril that is bleeding. Press for several minutes. This pressure alone often stops the bleeding. It reduces the amount of blood that flows from the tiny blood vessels in the nose. A clot can then form more easily. Can you explain why the clot will form faster?

If pressing the nostril doesn't stop the bleeding, put a cold, wet cloth over the nose. Then use pressure on the nostril again. The pressure and the cold towel will usually stop the nosebleed in a few minutes. The cold towel helps slow the flow of blood by making the blood vessels get smaller.

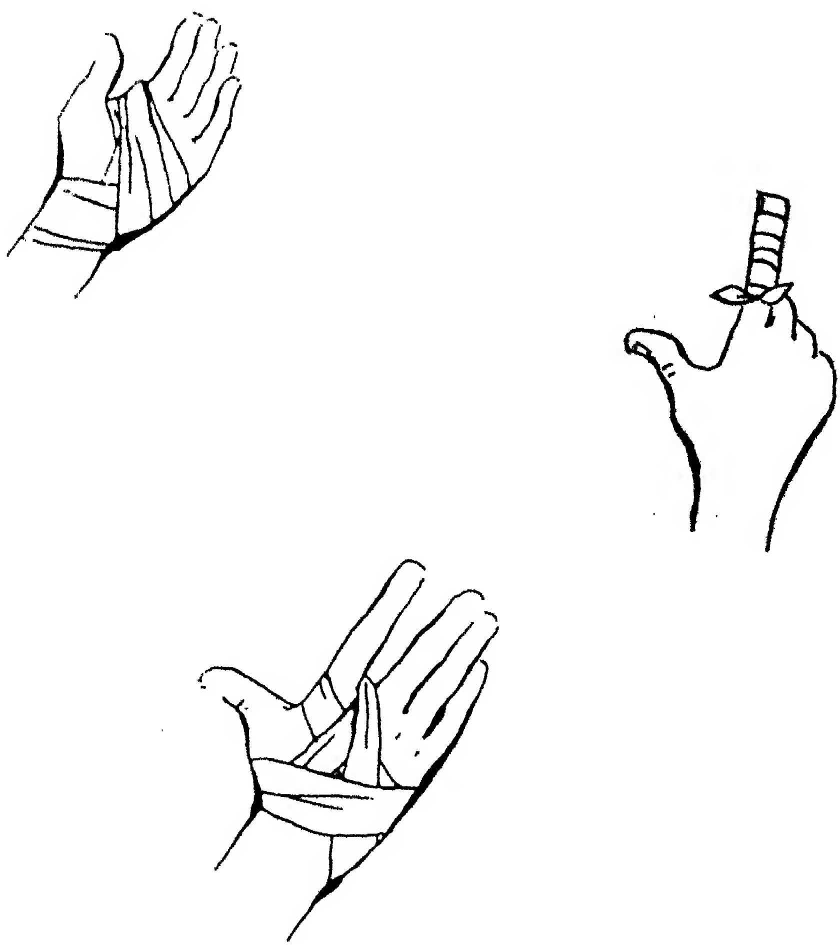
Once a nosebleed has stopped, the person should remain quiet for a while. He should not blow his nose because this may cause the clot to blow off and the bleeding to start again.

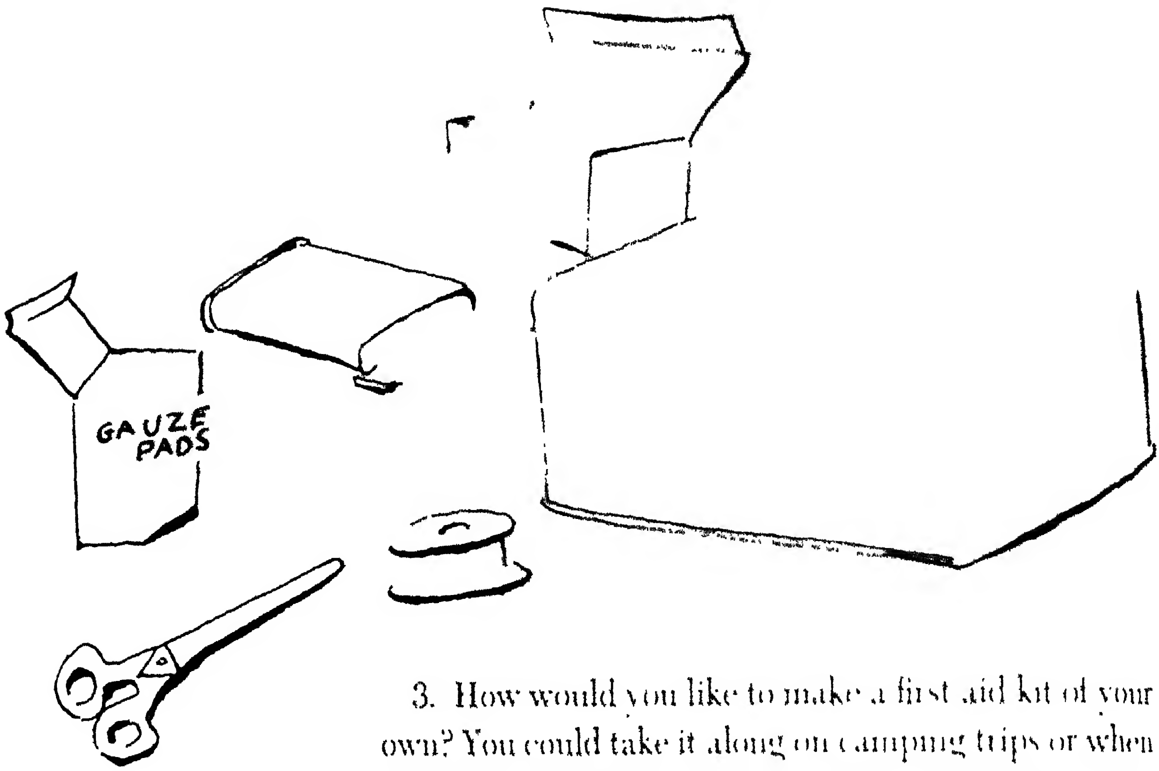
Things to Do



1. If you have a scar on your hands, arms, or legs, look at it carefully. How is it different from the skin around it? Is it the same color? Are there any hairs growing out of it? Does it feel the same as the skin around it when you touch it lightly with a pencil? What reasons can you think of for the difference?

2. Many wounds can be bandaged by taping gauze over the wound. But wounds on some parts of your body are more difficult to bandage. Get some tape and clean cloth or gauze. Then practice putting bandages on one of your classmates. Put them in the places shown in the picture.





3. How would you like to make a first aid kit of your own? You could take it along on camping trips or when you take a trip with your family. If your family doesn't already have one, yours could be for your whole family.

To begin with, you need a box that will close tightly. A cigar box or a metal candy box will do. Or you can make one out of wood yourself. Now that you have learned about first aid for wounds, what things will you need to get for your first aid kit? Make a list. Then compare your list with your classmates' lists.

Things to Talk About

1. Many people feel like running away when they see someone who has been injured badly, even if they know first aid. What can these people do to get over such feelings?

2. Picking scabs from wounds may harm a person in two ways. (1) It will take longer for the wound to heal. (2) The wound may become infected. Yet even children who know this often pick scabs. Why do you think they do this?

There are many ways you can get burned. Have you ever burned yourself on a hot object? Have you ever accidentally spilled something hot on yourself? Have you ever had a painful sunburn? With your classmates, make a list of all the different ways you have been burned. Look over the list. Mark the ones that could have been avoided if you had been more careful.

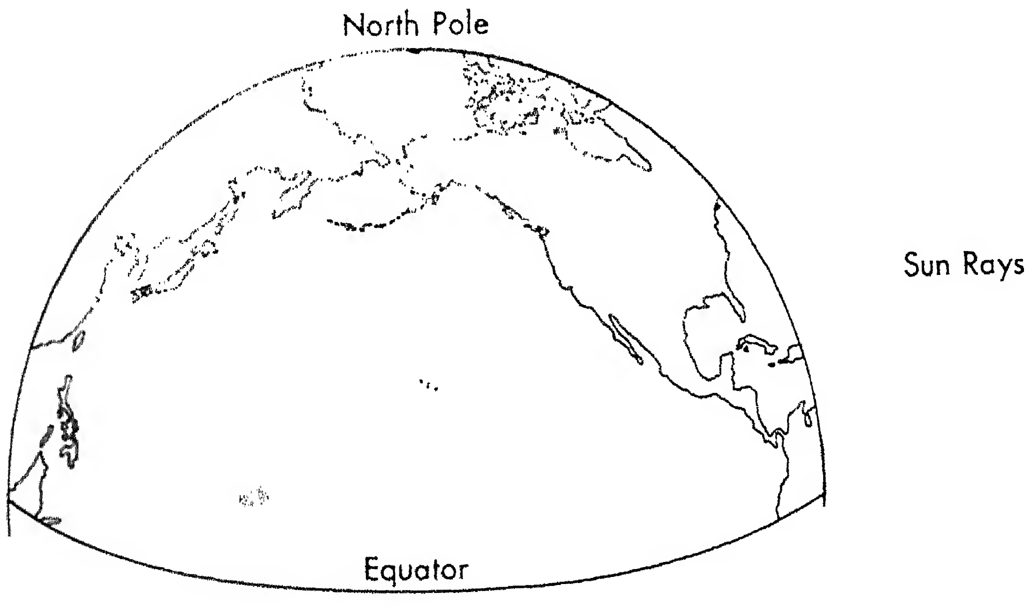
Sunburn

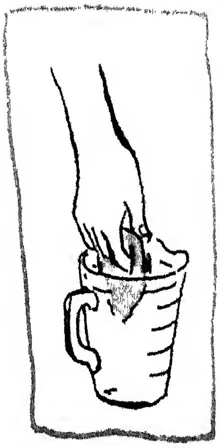
You probably get a sun tan every summer. Sun tan is helpful. The tan helps protect you from sunburn. Certain rays from the sun, called ultraviolet rays, cause your skin to get darker. Ultraviolet light shining on your skin manufactures vitamin D, which your body uses in making strong bones and in other ways. But if you get too much before your skin has darkened, it will cause sunburn.

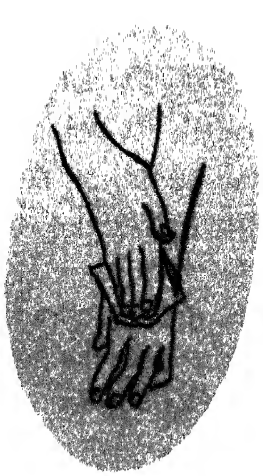
Sunburn injures the skin just the way other heat burns do. The skin reddens and blisters. It hurts. In a very severe case of sunburn, a person may have a fever.

To prevent sunburn, don't stay out in the sun too long at first. It takes time for your skin to tan. A little direct sunshine each day makes it possible for the skin to tan without burning. Remember, the sun's rays are strongest between 10 A.M. and 2 P.M. Between these hours you must be very careful not to overexpose your body.

The same amount of sunshine spreads over a much greater area near the north pole than near the equator. That is why the sun is weaker near the pole. Do you see now why you can usually get a sunburn more easily in Florida than in Maine?







Treating Burns

What was done for you when you were burned? Doctors have tried many different ways of treating burns. They are still trying to find better ways.

Here are some first aid suggestions for burns. If the burn just makes the skin turn red and nothing more, a burn ointment can relieve the pain and prevent the burn from becoming infected. Ointments for burns are sold in all drug stores.

If you have no burn ointment, you can do this. Mix three tablespoonfuls of baking soda in a quart of warm tap water. Dip gauze or any piece of clean cloth in the mixture and put it on the burn. If the cloth is kept moist, this mixture will keep the skin from hurting. Butter, lard, oil, and mineral oil also relieve the pain of burns.

Burn ointments may also contain a gentle chemical that prevents germs from growing and causing infection. This chemical does not harm the skin. A chemical that prevents germs from growing is called an **antiseptic.**

You can try a few experiments to see how some antiseptics stop tiny plants from growing. On page 33, you learned how to grow mold. You put some moist bread on a dish and exposed it to the air. After a day or two, mold appeared.

Grow some mold again. This time, see how antiseptics affect the growth of mold. Try to get several antiseptics, such as Merthiolate, mercurochrome, and alcohol. How will you plan your experiments to find out if these antiseptics prevent mold from growing? What comparisons will you make? Would you expect these antiseptics to act the same way on bacteria?

You should never put an antiseptic on a burn yourself. It may be too strong and make the burn worse.

First Aid for Poison Ivy

Poison ivy is common in the United States. Have you ever suffered from it? If you have, it's an experience you won't easily forget. The leaves, stems, and roots of the poison ivy plant contain small amounts of an oily substance that irritates the skin of most people. Even a tiny amount of this poison on the skin is often enough to cause irritation on some people.

Poison ivy often grows as a vine. You frequently see it climbing along trees and fences. Sometimes it grows as a crawling plant, so you will even find it along the ground.

In most wooded areas, you are in greater danger of being bothered by poison ivy than by any animal. The leaves are not the only part of the plant that give off the poison. It is found on the stems and even the roots.

The poison is irritating in tiny amounts. Some people don't even have to touch poison ivy to get the irritation. They can get it even if a poison ivy plant is burning and a little of the smoke touches their skin.

If you have had poison ivy, you can tell the class how your skin looked. It itched terribly. It was swollen and small blisters formed. The irritation may have lasted many days.

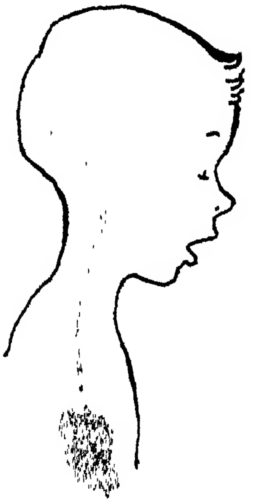
Some people think they cannot get poison ivy. They think that because they never got poison ivy, they never will get it. It is certainly true that some people seem to get it more easily than others. But almost any person who touches the plant often enough will get it. So even if you think you can't get it, you should still keep away from the plant.

In order to keep away from it, you need to know what it looks like. The picture shows you how to recognize it.

The next time you are in a wooded area, look especially hard for poison ivy plants. See if you can recognize them. Perhaps someone who knows about poison ivy plants can go with you to tell you if you are right.

Even if you can recognize poison ivy, you may sometimes get into it before you realize it. If you think you have touched poison ivy, wash yourself thoroughly with plenty of soap and hot water. Wash several times.

But washing may not be enough to keep the poison ivy from affecting you. If the blisters begin to appear on your skin, here's what to do until you see the doctor. First, wash thoroughly in warm water with lots of soap. Then dab your skin with a mixture of bicarbonate of soda and water. This will give some relief from itching.



A person feels faint when there is not enough blood going to the brain.

Fainting

When Nancy fainted in class, not many of the children realized that fainting is one of the most common emergencies that a first aider must take care of. A person faints when the blood vessels of his body become temporarily too relaxed. Then, most of his blood gathers in the lower parts of his body and legs. His heart is not able to pump enough blood to his brain. This can happen when a person stands still for a long time in a crowd on a hot day. A person can faint from being very tired. Some people faint when they see blood or receive very bad news or are suffering from severe pain. Any of these things can cause a person to faint. Sometimes the reason a person faints is unknown.

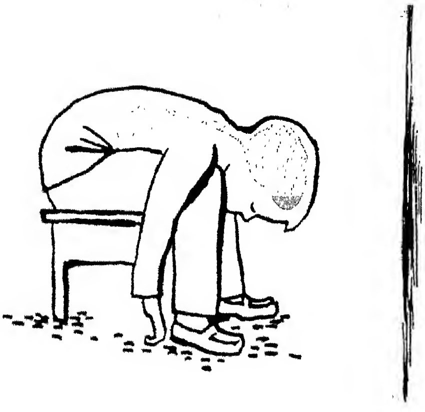
When a person faints, he falls down. His eyelids close. He doesn't hear. Many of his reflexes no longer work. Fainting is something like sleeping. But, of course, a person cannot control fainting the way he can control going to sleep.

Whenever a person faints—no matter what the reason—there is always an insufficient supply of blood in the brain.

When a fainting person falls down, blood reaches his brain more easily. The heart doesn't have to pump blood uphill.

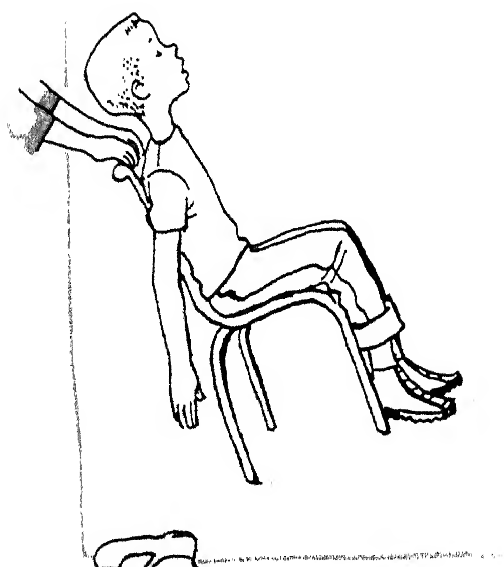
First Aid for Fainting

Often fainting can be prevented. Usually a person begins to feel weak and dizzy before he actually faints. When this happens, have him lie down. The purpose of first aid to prevent fainting is to get the person's head lower than his heart. When a person is lying down, his heart doesn't have to pump as hard to make blood reach the brain as it does when he is standing.



Here is another way to keep a person from fainting. Have him sit down and bend forward until his head is between his knees. In this position, his head will be lower than his heart. His blood will be able to reach his brain more easily.

If he can neither lie down nor sit down, have him kneel down on one knee and put his head down.

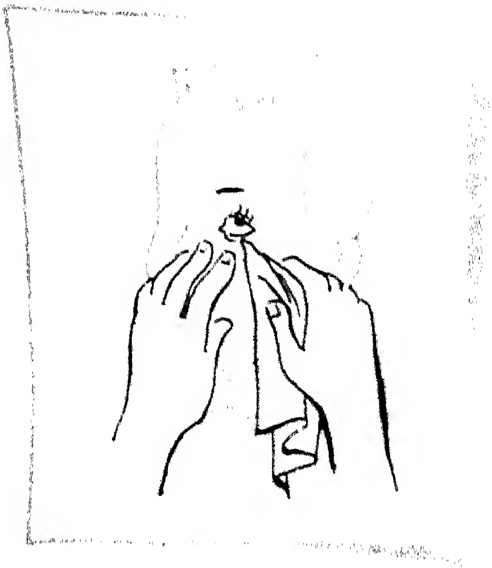


If someone has already fainted, make sure he is lying down. If the person faints while sitting in a chair, have someone help you tip the chair back or get him out of the chair and onto the floor. The blood will then flow more easily to his brain. This was the first aid treatment that Nancy's teacher used the day that Nancy suddenly fainted in class.

Usually a person who has fainted recovers quickly. Be sure you send for a doctor if the person doesn't recover in a minute or two.

Other First Aid Suggestions

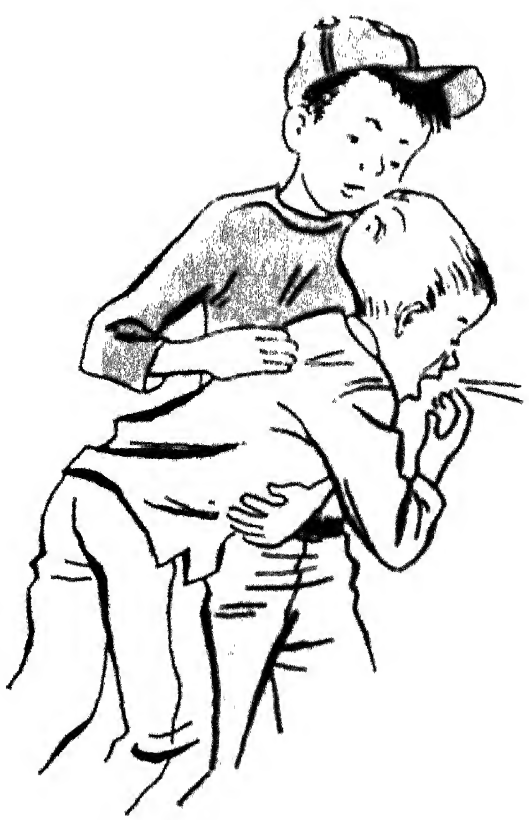
Here are some first aid suggestions for common accidents.



Dust or cinder in the eye

If the cinder is on the inside of the lower lid, pull down the lower lid. Lift the cinder off gently with the corner of a clean handkerchief. If the cinder is on the inside of the upper lid, take hold of the eyelashes, pull the upper lid down over the lower lid. Have the person try to look up—keeping his head still. The tears that form may wash out the cinder.

If these methods don't work, get to a doctor.

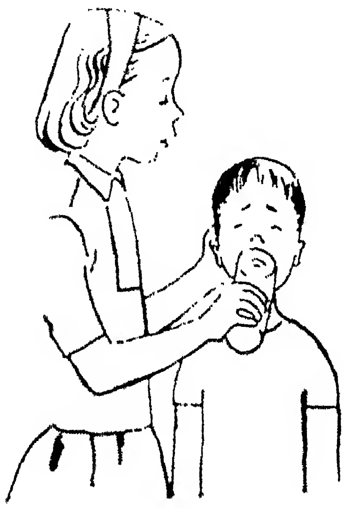


Choking from a bone or other object in the windpipe

Have the person bend his head as far down as possible. Slap him sharply on the back to try to force out the object. If this doesn't work, call a doctor.

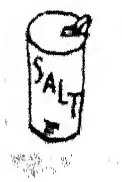
Bee sting

Try to remove the stinger if it is left in the skin. Make a paste by mixing a teaspoonful of bicarbonate of soda with a few drops of water. This paste will help stop the pain from the sting.



Small object stuck in the ear or nose

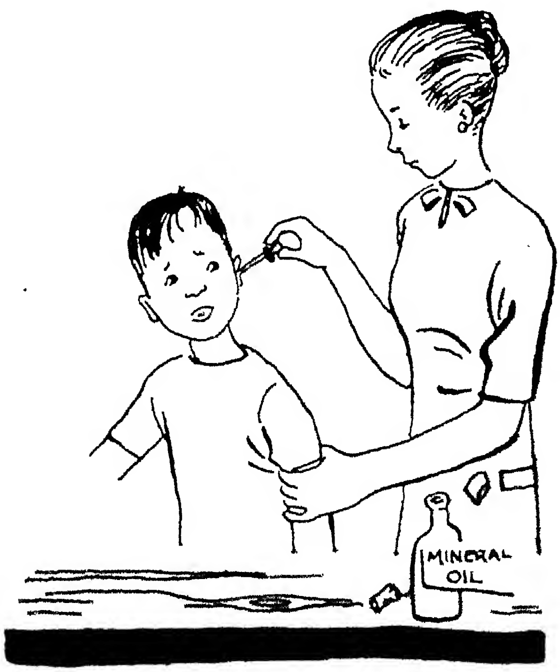
Don't try to dig the object out. You will only force it further in. If the object in the ear is an insect, a few drops of mineral or vegetable oil will kill it. See a doctor immediately.



Accidentally swallowing poison

Call a doctor immediately. Then have the person drink lots of water. This will make the poison weaker. Then let the person stick his finger down his throat until he vomits.

On the bottle of poison, there is information about other first aid procedures.



So far, you have read what to do in case of an emergency before the doctor arrives. But many of the emergencies don't have to happen. Does this seem strange to you? When many people say, "It was an accident," they mean it was something that couldn't be helped. This isn't always true. Most accidents don't have to happen. Let's see how they might be prevented.

One of the first things a scientist does when he has a problem is to gather together what information there is on that problem. If your problem is, "How can accidents to children be prevented?" you will need the following information about accidents.

1. Where do most accidents happen?
2. Do more accidents happen during some months than others?
3. Do boys have more accidents than girls?
4. Do more accidents happen to younger children than to older children?

Why would answers to these questions help in solving the problem? What might people do differently if they knew the answers? What other kinds of information might you find helpful?

You can begin collecting information about accidents right in your own class. You might make a survey of accidents that have happened to people since the beginning of school.

First, you will probably have to define what you mean by an "accident." This word doesn't mean the same thing to everyone. Mary might fall down and skin her knee and say she had an accident. But John gets so many skinned knees he doesn't even count them! He has to have something more serious happen to him before he reports it. Do you see why you must be sure, when you make a survey, that everyone has the same meaning for the word? You might start with the dictionary to define *accident*.

On the next page you will find part of a chart one fifth-grade class made after their survey.

Could the fifth graders answer all the questions on this page after their survey? What will they need to do to answer 2 and 4?

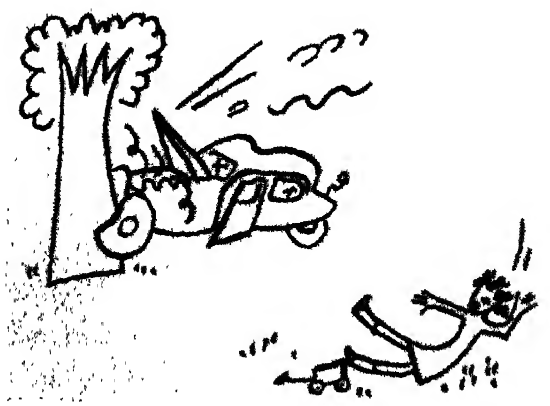
If you make such a survey of your class, you might be interested in comparing your information with what is known about accidents in other parts of the country. The National Safety Council and various life insurance companies have collected a great deal of useful information about accidents. On page 146 is a chart showing some of this information.

Name	*Injury*	*Where Accident Happened*	*How Accident Happened*	*How to Prevent Such Accidents*
Barry	Rope burn	Home	Rope got caught as I ran out door.	Don't let rope trail behind. Don't run indoors.
Sheri	Skinned knee	Edge of sidewalk	Fell off bike	Walk bike off edge of side-walk.
Philip	Chipped tooth	Street	Racing my brother on dark night. I tripped.	Don't run in the dark.
Miriam	Bruised leg	Playground	I got kicked in fight.	Try to avoid people you always fight with.
Madeline	Cut finger	In park on cookout	Peeling potatoes	Peel slowly and carefully, keeping knife well away from hand holding the potato.
David	Blister on hand	Backyard	Raking leaves	Tape gauze on tender spots.

These are some of the findings of the National Safety Council.

1. More accidents causing injury happen in the home than anywhere else. In a recent year, 4,100,000 injuries were caused by home accidents. There were 27,500 deaths.

2. Reports from fifth-grade classrooms in a recent year showed that about two-fifths of all injuries outside school happened in the home. Of these, one-eighth were from cuts and scratches and about another one-eighth were from falls. Seven percent of all the accidents happened while the fifth graders were riding bicycles.



3. More accidents causing death happen on the highway than anywhere else. In a recent year, 36,000 deaths resulted from auto accidents. There were 1,250,000 injuries.

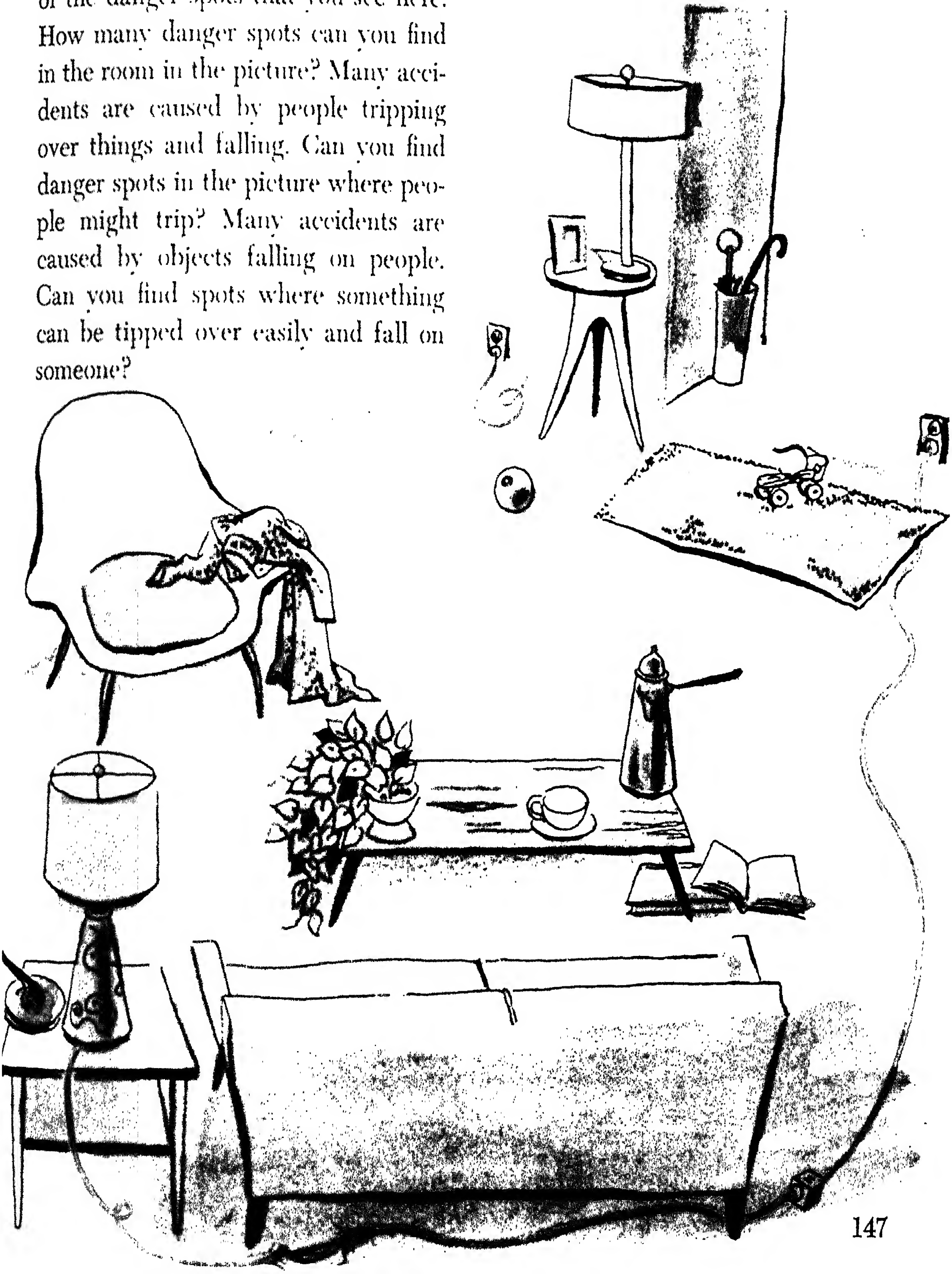
4. More accidents of all types except drowning happen among children from birth to four years old than among those from five to fourteen.

How do some of these findings compare with those of the fifth graders that made the accident survey? How do they compare with your survey?

A survey will probably help you find some ways in which accidents can be prevented. Look at the survey chart on page 145 again. You will see many different suggestions there for preventing accidents. Each suggestion is different because it refers to a special accident. Let's see how some of these might be grouped. "Removing hazards" might be the first big group. Hazards are things that may be dangerous to safety.

Removing Hazards

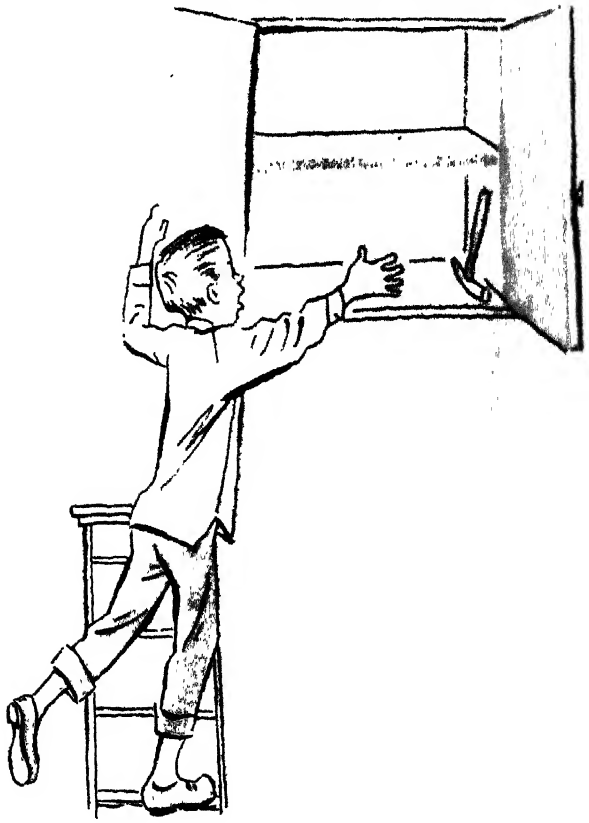
Probably no room is so dangerous as this one. But many rooms have some of the danger spots that you see here. How many danger spots can you find in the room in the picture? Many accidents are caused by people tripping over things and falling. Can you find danger spots in the picture where people might trip? Many accidents are caused by objects falling on people. Can you find spots where something can be tipped over easily and fall on someone?



Making Climbing Safe

Falls from high places also cause many accidents each year. Harry is reaching for a hammer in the back corner of a high cabinet. To reach the high shelf, he climbed a ladder. Then, when he saw the hammer in a far corner, he leaned out to get it. He was in a hurry. Notice how far he must lean from the ladder to get his hammer. If he leans too far, the ladder will tip.

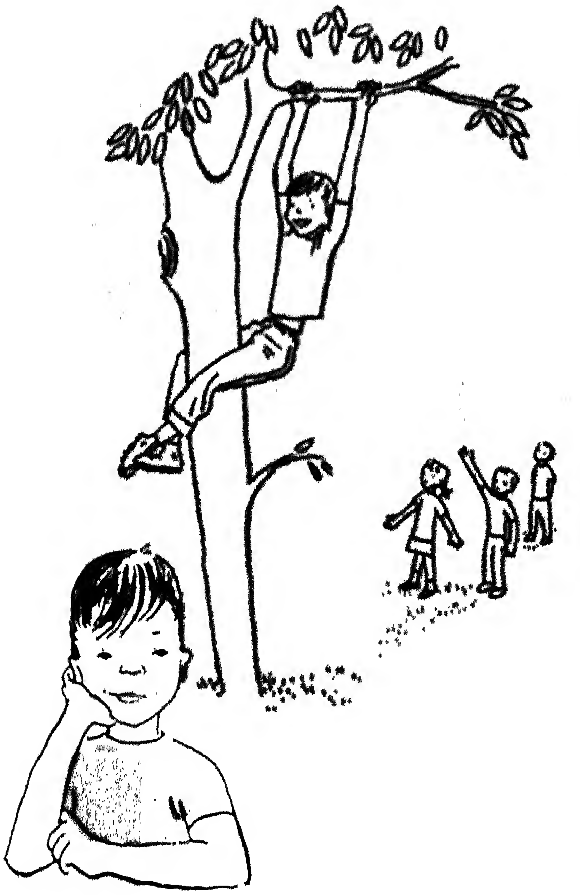
To be safer, Harry could move his ladder closer to the shelf where the hammer is and climb up again. By doing this, more of his weight would be centered over the ladder. It might take him longer, but it would be safer. Many accidents happen when people try to get something done in a hurry.



Understanding Feelings

Still another way in which accidents can be prevented is to try to understand the feelings that may cause accidents. Let's see the connection between feelings and accidents.

If the names of all the children having accidents were reported on page 145, you would notice something interesting. Some people seem to have more accidents than others. Mike, for example, had more serious accidents than anyone else in the room. He broke an arm, had stitches in his leg, and had a tooth knocked out. Is Mike just plain



unlucky? This is a question scientists were curious about. They set out to find the answer.

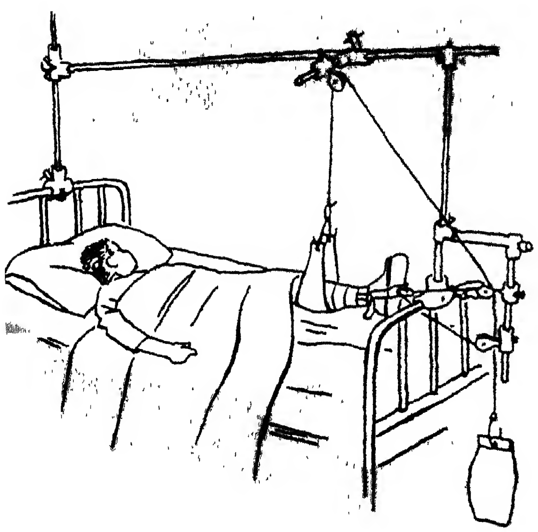
One scientist had the hunch that maybe some boys and girls get into more accidents than others because of their feelings about themselves. You remember in the section on personality, you found out that your feelings about yourself can make you behave in certain ways. This scientist studied boys and girls who had had five or more serious accidents. He found out some interesting things.

Some boys and girls who get into many accidents seem to be unhappy about themselves. Take the case of Mike, again. Mike wants people to admire him but he doesn't feel that he gets quite enough attention. In his favorite daydream, he sees himself surrounded by other boys who are patting him on the back and praising him for some wonderful thing he has just done.

Maybe you've had daydreams like Mike's. But Mike tries to make the dream come true in an unfortunate way. He tries to do things that the other boys wouldn't do—hoping that they will admire him. That's why he climbed trees that weren't strong enough, used a sharp knife carelessly and rode "no-hands" on a busy street. He wanted to show that he was not afraid. He wanted his friends and family to admire him for his courage.

Wanting people's admiration isn't the only reason some people get into more accidents than others. What other feelings might a person have that would cause him to "invite" accidents?

Some people want to prove to themselves that they aren't afraid to try dangerous things. Boys and men are usually the ones who take chances for this reason. They will try balancing themselves on top of a high fence, or rocking a rowboat to see how far they can tip it. They do these things because they don't feel very sure of themselves. But sometimes these people fall off a high fence when they try to balance themselves. Sometimes they fall into the water when they tip a rowboat too far. These people get injured often. They have broken bones more often than other people. They get cuts and bruises more often than others.



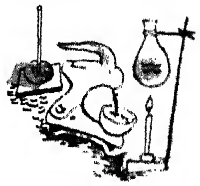
People who do these dangerous things to get admiration usually don't realize the exact reasons why they have accidents so often. They usually think they are just unlucky.

Scientists think there are still other feelings that cause people to have frequent accidents. Some people like the attention they get when they are injured and wrapped in bandages. These people may not realize that they really want this attention.

But this kind of person always finds himself with bandages and gauze pads on various parts of his body. And he gets his bandages by getting into accidents.

Of course not all accidents are caused by people's feelings. Some accidents are really accidental. Usually, feelings have nothing to do with a cinder getting in your eye or a bee stinging you. It is only when one person seems to have many accidents that we say his feelings may be the reason.

Things to Do



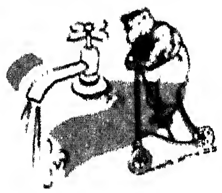
1. Make a check of your school halls and playgrounds. Look for spots where people may trip over things. What can you do to make these spots less dangerous?

2. Act out a scene in which a person's feelings cause him to have an accident.

3. Hang a large card with the letter "A" everywhere in your school where there has been an accident. Do you think such cards will help people be more careful?

4. If you started the first aid kit back on page 136, you are now ready to add some more supplies to it. From what you have read since starting the kit, make a list of the things that you will want to add to it.

Things to Talk About



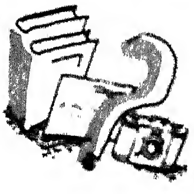
1. What is the safest way to drive a nail with a hammer?

2. What is the safest way to use a paring knife?

3. Read again the section on "Understanding Feelings." Make a list of some of the kinds of feelings that may cause accidents. Can you suggest some better ways for these people to get what they want?

4. In a recent year, more than one-fifth of the deaths from accidents were caused by falls. Are there places in your classroom where people can easily trip? What things can you do to make these places safer?

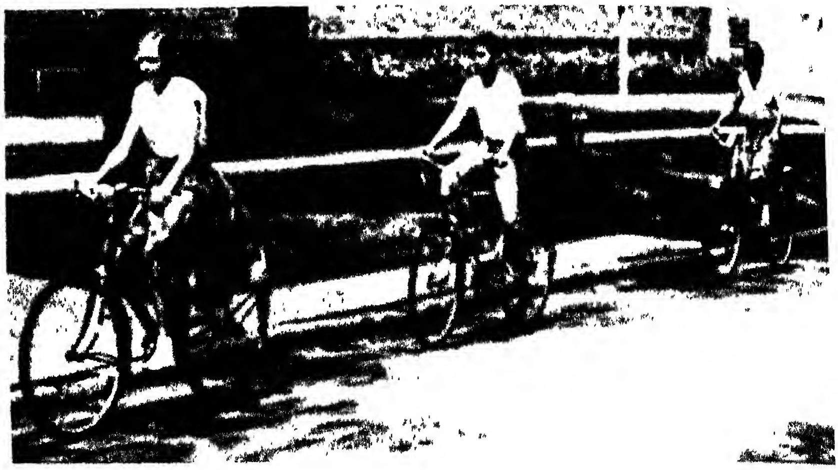
If You Want to Find Out More



1. Since there are so many bad accidents every year, find out what special things are being done in your community to make driving safer?

2. "Shock" often results from an accident. What is "shock"? What is the best first aid for it? Look up shock in a first aid handbook.

National Safety Council



BICYCLE ACCIDENTS

How many in your room have bicycles? How many have had accidents with them? What caused the accidents?

The National Safety Council and insurance companies try to reduce the number of bicycle accidents that people have. They do this by making surveys to find out what kind of accidents people have and how they were caused.

In a recent year, these organizations found that bicycle accidents killed about 600 people in the United States. They injured 30,000 more. You can see from these numbers that bicycles can be dangerous.

Collisions with cars, buses, and trucks cause most bicycle accidents. In fact, such collisions cause more than four-fifths of all the deaths on bicycles. Falling off bicycles, riding into trees and fences, and riding into people walking cause accidents, too.

Most accidents resulting in death were caused as the bicycle rider swerved into the path of a car, truck, or bus. Others were caused by coming out of a driveway without looking and by entering the street from behind parked cars. Still others were caused by racing on bicycles.

Have you had bicycle accidents from some of these causes? Do you know anyone seriously injured in a bicycle accident? Was the cause similar to those mentioned here?

In one survey, it was discovered that youngsters between the ages of five

Portland T...

These pictures suggest ways of making bike riding safer. Bike practice gives you surer control. Keeping near the curb and watching traffic signals help cut down on accidents.

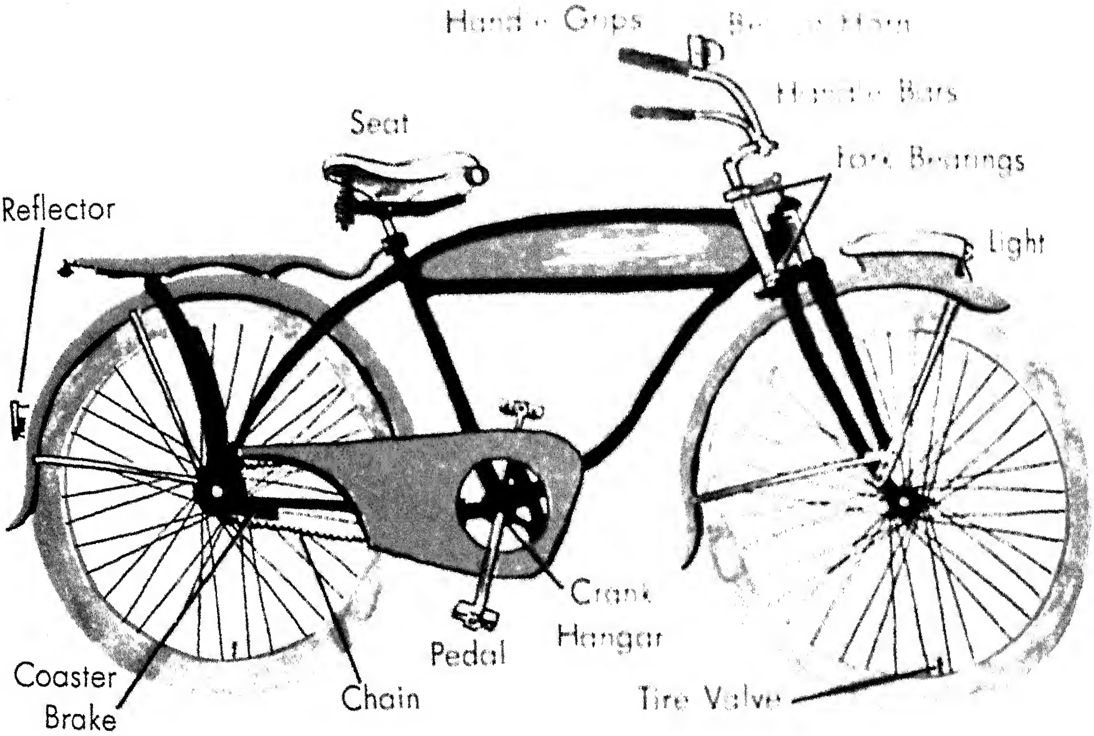
and fourteen account for two-thirds of the people killed each year in bicycle accidents. Boys were in ten times as many bicycle accidents as girls.

Out of the surveys made came suggestions like the ones listed on this page. Can you think of the reason for each rule? Perhaps you can have a class discussion on the reasons for these rules.

Some schools have bicycle safety programs every year. In these school safety programs, young people learn how to use their bicycles safely. They find out what causes most bicycle accidents. Then they learn how to avoid the most common types of accidents. These school safety programs have helped greatly to reduce the number of serious bicycle accidents.

Bicycle Safety Rules

1. Ride your bicycle in the same direction as the traffic is moving.
2. Ride only as fast as safety permits. Ride slowly on crowded or slippery streets.
3. Be careful not to cut in and out of traffic.
4. Make turns carefully after looking around to make sure nothing is coming.
5. Watch and obey traffic lights and stop signs.
6. Watch out for people opening car doors.
7. Look carefully before coming out of driveways or from between parked cars.



Check your bike. If necessary, have someone help you. Can you answer yes to each of these questions?

Are wheels steady and oiled?
Is seat secure and at right height?
Are handle grips tight?
Are handle bars secure and at a comfortable height?
Does bell or horn work?
Can light be seen 500 feet away?
Can reflector be seen 300 feet away?
Are fork bearings oiled?
Does coaster brake work evenly?
Is crank hangar steady, clean, and oiled?
Is chain whole, snug, clean, and oiled?
Are pedals secure and oiled?
Are tire valves free from leaks?
Are tires properly blown up?

Check Your Bicycle for Safety

But you have to do more than obey safety rules. You have to check your bicycle regularly to make sure it is in good condition. The drawing on the opposite page shows how to check your bicycle.

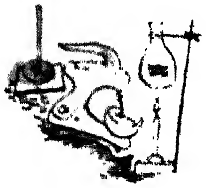
A good safety measure for people who sometimes use their bicycles after dark is to have a bicycle painted a light color rather than a dark color. You can try an experiment to see for yourself how different colors reflect different amounts of light. This comparison will also help to show you the importance of wearing light colors at night.

Darken your classroom as much as possible for this comparison. Then shine a flashlight first on a dark sheet of paper and next on a light sheet of paper. The flashlight is like an automobile headlight. The sheets of paper stand for bicycle riders. Which sheet of paper can you see more easily? Compare several colors to see which can be seen most easily. Your comparison will help you understand why some colors are safer to wear at night than others.

An automobile driver sees your bicycle at night because the light from his headlights is reflected back to him from your bicycle. Light colors, like white and yellow, reflect more light than the darker colors, like black and brown. For this reason it is safer to wear light colored clothing for night riding.

In this unit you have learned about accidents. You have learned what causes many of them. You have also learned what you can do to prevent them and to help yourself or others when accidents happen. But the most important first aid suggestion is this. When there is a bad accident, get a doctor as soon as possible.

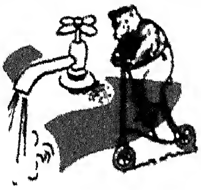
Things to Do



1. Write a scene for a play to show the reason for one safety rule. Act out your scene. Perhaps you can show it to another class.

2. If you live in a part of the country which has tornadoes or floods, find out if your town has a plan for a sudden emergency, like a tornado or a flood. What is the plan? Maybe the Red Cross can help you get information. Maybe you will have to write to the Civil Defense Office.

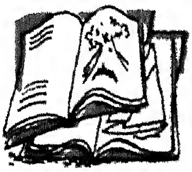
Things to Talk About



1. Do children have more accidents than adults? How can you find out? What reasons can you think of to explain why one group may have more accidents than the other?

2. Has there ever been a safety campaign in your town? Find out who organized it. How did it work? Are there fewer accidents than there were before the campaign?

Things to Read About



1. Find out the best first aid procedure to help a person who has almost drowned. A first aid handbook has this information. Perhaps you can practice artificial respiration on a friend.

2. Find out what poisonous snakes live in your part of the country. In what kinds of places would you be most likely to run into them? Find out how you can protect yourself from being bitten if you go near these places. What should you do if a poisonous snake bites you? Also, find out how many kinds of snakes that are not poisonous live in your part of the country.

If You Want to Find Out More

1. Does having the proper air pressure in your bicycle tires make it easier for you to guide your bicycle? Plan an experiment with your bicycle to answer this question.

2. Does your town have special traffic laws for bicycle riders? Write to your police department to find out. Perhaps a policeman could visit your class to explain these laws.

3. Make a plan for a school bicycle safety program. Where could you have it? Who would take part in it? What adults could help you? Write to the National Safety Council at 425 North Michigan Avenue, Chicago 11, Illinois, for their booklet on bicycle safety.

7 *Finding Out How Animals Learn*

About "*Finding Out How Animals Learn*"

Have you ever seen a chimpanzee ride a motor scooter? Have you ever seen a dog dancing with another dog? Trained animals like these have appeared on TV.

If you have a pet, perhaps you would like to train it to do something. You might want to teach your dog to come when you call him. Or it might seem like fun to teach a bird to tap on his cage whenever he wants food. Even an aquarium fish can learn to come to the surface when you tap his bowl. There are many things you can teach an animal.

This unit will tell you some of the things psychologists have found out about how animals learn. You will discover that you learn in much the same way. Can you tell why? Knowing how animals learn should help you, not just to train your own pet, but also to understand how you learn.

THE FOUR PARTS IN LEARNING

If you have ever tried to teach an animal to do something, you know it's not easy. When Chipper, the Jones' dog, is called, you should see him run—the other way! And their cat will climb onto the kitchen table no matter how hard they try to break him of the habit.

Teaching an animal takes time and patience. But time and patience aren't always enough. If you do the wrong thing when you are trying to train your animal, he may learn to do just the opposite of what you want him to do. Suppose your dog ran away when you were teaching him to come. Suppose you ran after him trying to catch him. What would he do? What would he learn?

Let's go back to the Jones' dog, Chipper. When Chipper was still a puppy, he was let out in the yard by himself. Chipper rolled in the grass until he was tired. At first, when he wanted to get back into the house, he would just sit on the doorstep, *wanting* someone to let him in. He would wait until someone noticed him. A few times he tried scratching against the screen door. Perhaps he was trying to see if he could push open the door by himself. He tried other things, too. But soon he *noticed* that whenever he scratched, someone opened the door. He tried scratching every time he wanted to come in. It worked each time. Someone opened the door for him. He had *learned* how to get into the house whenever he wanted.

What Is Learning?

What do we mean when we say Chipper *learned* something? We mean he changed his behavior. He changed the way he behaved because of things that happened to him. Chipper used to sit on the doorstep and wait. Now he scratches the screen. What happened that made him change?

All of us learn the way Chipper learned. How do you know when it is time to go home from school? Probably you don't even need a bell or a clock to tell you. Perhaps it's the way your teacher calls the class to order. Perhaps you hear noises of pupils from other rooms getting ready to go. Perhaps your stomach tells you. Why do you stay in bed an extra ten minutes after your mother calls you? You have probably learned from the sound of her voice when she really means business about your getting up!

You learned these things so easily that it is hard to know when it happened, or even that it has happened. What are some things you have learned recently? How do you know when you have learned these things?

We Learn Wrong Ways, Too

Not all our changes in behavior are right or good changes. Chipper's way of getting back into the house wasn't a good way for the Joneses. When Mr. and Mrs. Jones saw what was happening to their screen door, they didn't like it at all!

If the teacher asks you how much 8 × 8 is, and you say 65 each time instead of 64, you have learned the wrong

What does Chipper want?

What does Chipper notice?

answer. If you get angry every time your team loses a baseball game, you have learned to do the wrong thing. We learn wrong answers and wrong ways of behaving just as we learn right ones.

How We Learn

If we examine Chipper's learning closely, we can find out how learning takes place. Then we can see what we need to do to train a pet. We can also see how *you* learned when it is time to go home. We can see how you learned to play the piano, to be a good sport, or any other things you have learned.

The first thing we notice about Chipper's learning is that he *wanted* something. He wanted to get back into the house. This is important. In order for an animal to learn, it must want something. It may want food, or warmth, or sleep, or something else. Wanting something is the first part of learning.

Chipper also had to notice something. Since he can't tell us, we can't be sure of what he noticed. He tried different ways to get into the house. But perhaps he noticed that when he scratched the screen with his paw, someone opened the door. Perhaps there was some other sign that stood out. Noticing something is another important part of learning.

Chipper also did something. He did the dragging, or the scraping, or whatever it was that seemed to get results. Doing something is another important part of learning.

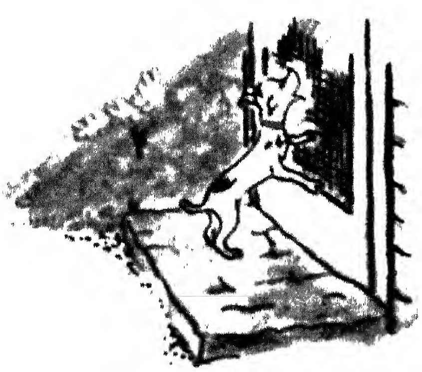
What if Chipper had scratched on the screen and the door had never opened? The chances are that he would have stopped trying to get into the house that way. But Chipper got what he wanted by scratching. Getting something is also an important part of learning.

These, then, are the four parts to learning:

1. Wanting something
2. Noticing something
3. Doing something
4. Getting something

Let's see how we can use these parts to teach a dog to come when called.

What does Chipper do?



What does Chipper get?

TEACHING YOUR PET

Tom Jones got tired of chasing Chipper all over the yard when he wanted him to come in. He decided it was time Chipper learned to come when he was called. Let's see how Tom used the four parts to learning.

Tom began Chipper's training period when it was time to feed him. Why did he choose this time? Which step in learning was he remembering?

After Tom had fixed Chipper's food and was ready to set it down for him, he called, "Here, Chipper. Here, Chipper." Of course Tom didn't really need to call Chipper to come to eat! Chipper was right under his feet all the time Tom was getting the food ready. But why did Tom call Chipper? What did he want Chipper to notice?

Chipper wasn't always around when Tom fixed his food. Tom saw to that. Sometimes he fixed the food when Chipper was in another part of the house. Then Chipper got a whiff of the food from a distance at the same time that Tom called him. Which step in learning was Tom taking care of?

Each time Chipper came when he was called, he got something. At first it was his dinner. Then Tom tried calling him when it wasn't mealtime. If Chipper came, Tom would give him a scrap of food or a piece of dog candy as a reward.

Perhaps you have seen an animal trainer on TV give an animal a treat when the animal does something very hard. It is important to reward an animal for doing what you want him to do. The reward doesn't always have to be food. Sometimes it's enough to pat the animal.

Tom spent a few minutes each day practicing with Chipper inside the house. When he was sure the dog had learned to come, he practiced with the dog outdoors. At first he practiced only when Chipper was near. But by the time his dog was a little over a year old, Tom could call even when Chipper was out of sight.

Trainers have used the four parts to learning to teach animals some remarkable things. A baby chimpanzee has been taught to feed herself with a spoon and to sew. Chimpanzees have also been taught to ride bicycles, use roller skates, and even to put on clothing.

You may have watched a Seeing Eye dog that has been taught to help blind people avoid dangerous objects. These Seeing Eye dogs are so well trained that they will lead their masters away from danger—even if they are in no danger themselves. For example, if a high bar that the blind person might walk into is blocking the street, the dog will stop.

A well-trained chimpanzee performing on television

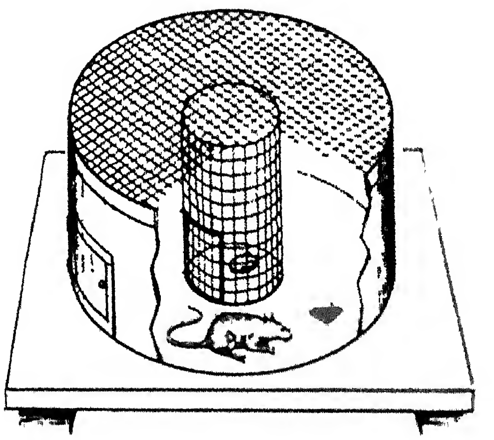
NBC

Seeing Eye dogs are trained to stop at curbs. In that way, the master knows he is at a crossing. The dog watches the traffic and leads his master across when it is safe. The dog does not watch the traffic lights. Dogs are color-blind.

The Seeing Eye, Morristown, New Jersey

The dog will stop even though it could get under the bar safely by himself. With a clever trainer, animals can be taught many useful and amusing things.

You might enjoy training an animal if you have never tried it. It's usually more fun having a pet that will do things for you. You can even make a plan for teaching some pets something useful, such as fetching the paper or getting your shoes.



Some Animals Learn More Easily Than Others

Is a rat more intelligent than a cat? Is a chimpanzee more intelligent than a dog? Is an elephant more intelligent than a tiger? Which of the common household pets learns fastest: cat, dog, canary, or parrot?

We know the answers to some of these questions. These answers have come from comparing what animals of one kind can do on a test with what animals of another kind can do on the same test.

In the picture, you see the equipment for a simple test of animal intelligence. In the inner cage there is food. In the outer cage there is a colored square. If the animal steps on this square, the inner cage will open. Then he can get the food. Our question is: How many times must the animal try the problem before he learns to step on the colored square in order to get the food he wants?

When the hungry animal sees the food, he will first explore the cage. Then he will try to get the food any way he can. He may jump on the cage. He may paw at it. But he will soon discover that none of these ways gets him the food.

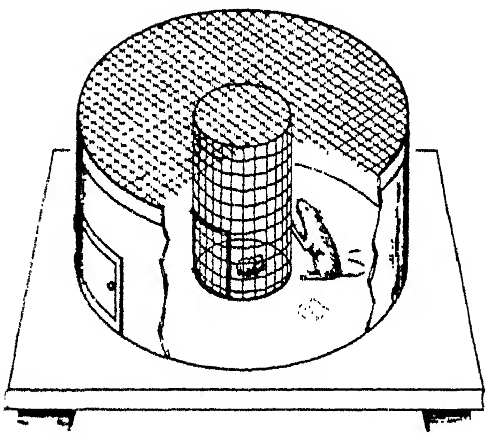
Then the animal may quiet down and look around. Maybe accidentally he will touch the red square on the outside. Immediately, the cage opens, and the animal gets the food. The next time the animal is put into the cage, he may try different ways to get the food just as he did the first time. Again he may touch the red square by accident. The cage opens immediately when he does this. After a number of times, the animal learns to go right to the red square in order to open the door, without trying other ways first.

In an experiment something like this one, psychologists found that a cat tried six times before he learned how to get the food. A dog solved the problem in only four tries. By seeing how many times each animal must try before it solves the problem, the psychologist gets an idea of how intelligent one animal is compared to another. But can the psychologist tell if he tests only one animal of each kind? If one dog solved the problem in fewer trials than one cat, does this prove that dogs are smarter than cats?

The scientist must be sure that he doesn't draw conclusions when he has used only one dog and one cat for comparison! Experiments on animal intelligence are always carefully planned. Then they are repeated with many animals before the scientist is sure of his results.

Also, if the psychologist is comparing one group with another, he must be sure both animals are *able* to do what they have to do to get a reward. For example, if they have to pull a string instead of stepping on a square, the cat would do better than the dog. A cat's claws could grasp the string better. If cats do better on such a test, does it mean that they are more intelligent than dogs?

Here's another experiment psychologists have tried. They wanted to see if an animal could learn to step first on one square and then on another to get the food in a cage. In the equipment in the picture, the animal will get the food only if he steps first on the red square and then on the blue one. If he steps on one only, he gets no food. If he steps on the squares in the wrong order, he gets no food. He must step first on the red one and then on the blue one.



The psychologists then found out which animals learned to step on the two squares in the right order. A dog could. A cat could. But a guinea pig couldn't! The two-square problem was far too difficult for him. This is one of the experiments that have helped psychologists find out which animals can learn to solve harder problems than others.

Planning Your Own Experiments

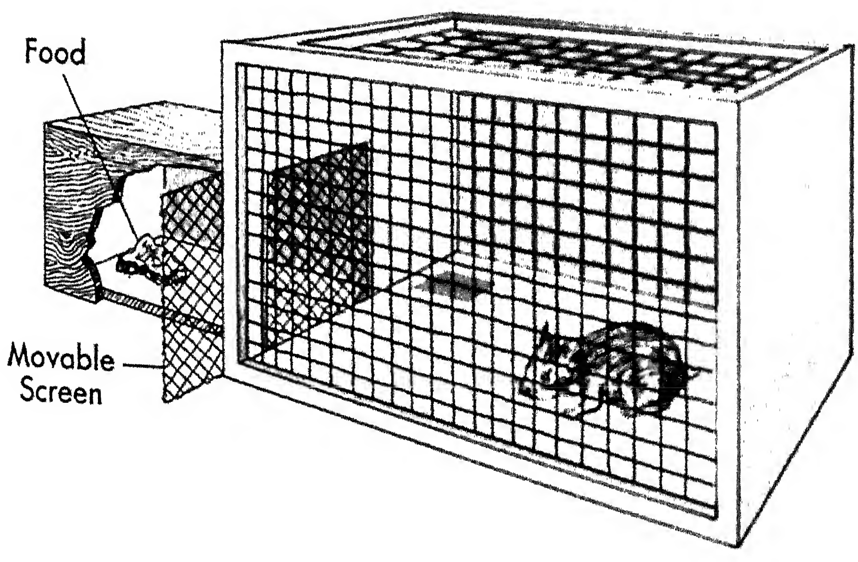
Perhaps you can try experiments in your own classroom similar to those that are tried in scientific laboratories. How could you find out if a guinea pig were more intelligent than a hamster? Or a hamster more intelligent than a mouse?

One way to find out would be to try the square experiment that has already been described. Prepare a cage large enough to hold the smaller food cage and to give your animal a chance to explore. Or you can arrange the cage and food holder as shown in the drawing on this page.

When a psychologist in a laboratory tries this experiment, he usually has automatic equipment. When the animal steps on the square in front of the laboratory cage, the door opens by electricity. If you try this experiment in your classroom, you will probably have to open the food cage yourself. Open it as quickly as you can when the animal touches the square.

Your food holder doesn't have to be a cage. It can be any box you can open and shut quickly. In the drawing below, you see a simple, homemade wooden box that could be used for the experiment.

With homemade equipment, it may take your animal a little longer to learn how to get the food. Animals learn better if they are rewarded as soon as they step on the square. If you open the door yourself, it may take a second or two.



Which Animals Are Most Intelligent?

Psychologists have tried quite hard square problems to find out about animal intelligence. In one experiment, they tested guinea pigs, rats, kittens, and monkeys. The animals first had to step on a particular square to get food. When they learned to do this, they had to learn to step on two squares in a certain order. The next job called for stepping on three squares in a certain order. There were five problems in all. Monkeys did the best on this test, then kittens, then rats, with guinea pigs at the very bottom of the list.

By trying experiments such as these, psychologists have found that chimpanzees can solve the most difficult problems. They can put sticks together to pull food out of a cage. They have the intelligence to stack boxes one on top of the other to get a hanging banana. They can learn to use a toothbrush, to turn on a faucet, and even to sew. Other very intelligent animals are the gorilla, the gibbon, and the monkey.

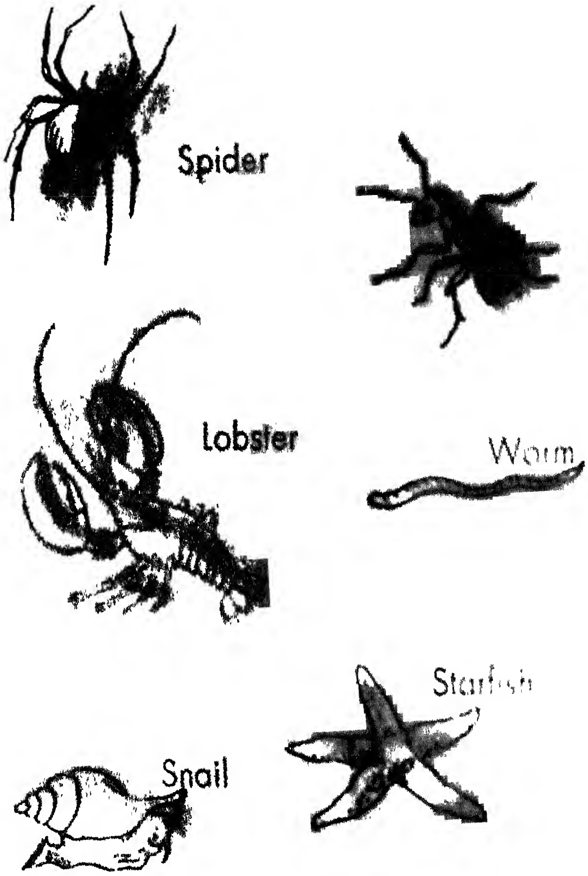
But psychologists can't test the intelligence of all animals. Imagine trying to figure out how intelligent a whale is! There are some animals that can't be tested in the kind of laboratories we have now. Also, animals differ in the problems they can solve because of the way they are built. Some animals can use their paws to take hold of sticks, but most animals can't be tested on this kind of problem. In fact, it is hard to think up a problem that could be used for testing all animals. For example, could you use the square problem for testing fish?

But scientists do have some ideas about how intelligent different animals are. At the very bottom in intelligence are the animals without backbones. We call such animals **invertebrates.** Snails are invertebrates. So are worms. So are ants and bees. Can you name others?

At the top in intelligence are animals with backbones. Animals with backbones are called **vertebrates.** Fish are vertebrates. So are snakes. So are dogs and monkeys. Can you name others?

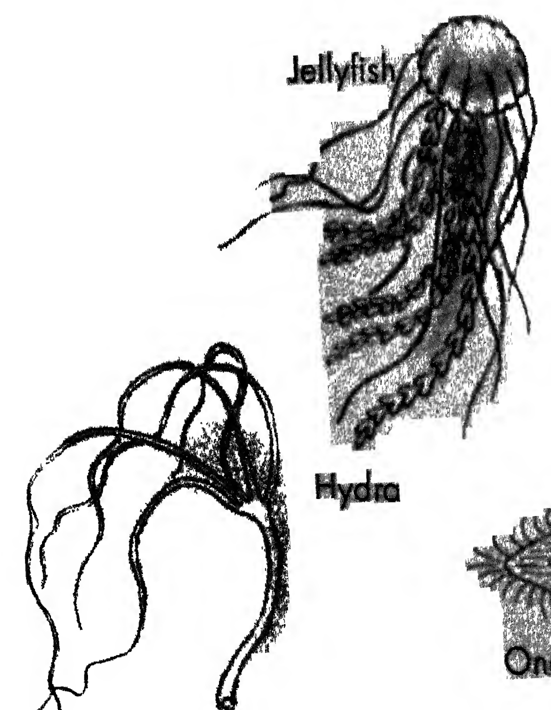
The simplest invertebrates are one-celled animals. Tests show that even they *appear* to learn. Invertebrates made up of many cells can learn harder things. Worms can learn the habit of taking the path to the right in a tunnel if they are given an electrical shock every time they turn left.

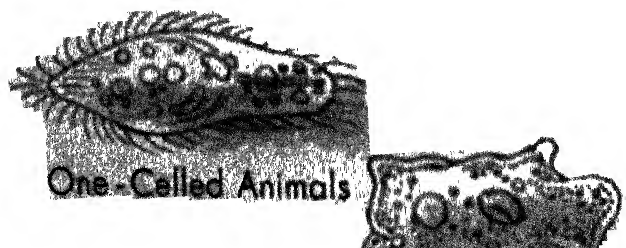
Of all the invertebrates, insects learn the best. Ants, for example, can learn their way through very complicated tunnels. Cockroaches like to stay where it is dark. But you can teach a cockroach to stay in the light by giving him a shock when he starts to go into the dark.



The lowest vertebrates and the highest invertebrates seem to have about the same intelligence. Snakes can learn their way through a tunnel about as well as ants can. Fish and frogs are also rated about as intelligent as ants.

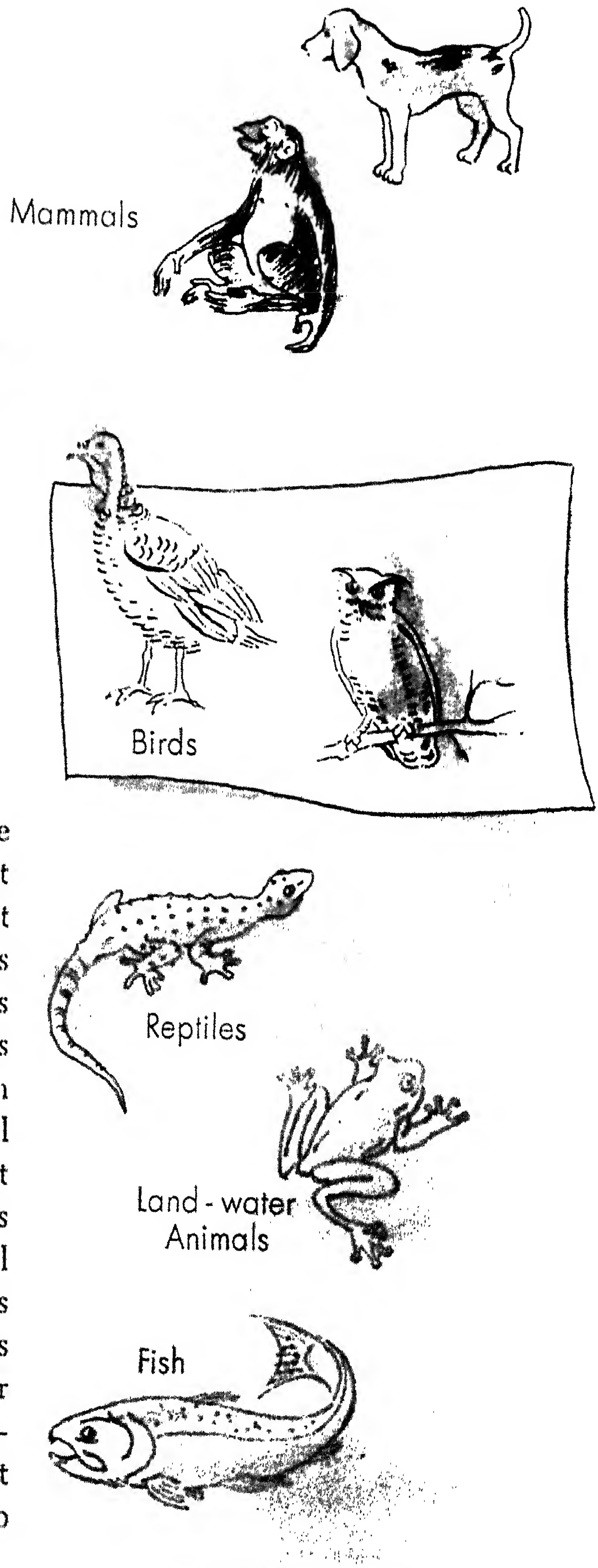
The most intelligent group of animals are the **mammals**. Mammals are different from other vertebrates in many ways. One difference is that their young are fed milk produced by special glands in the mother's body. Mice, rats, cats, dogs, apes, and human beings are all mammals. These animals are more intelligent than other vertebrates and all invertebrates. Can you name other animals that would be more intelligent than a snake?





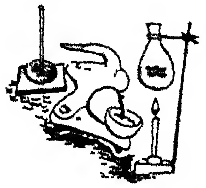
INVERTEBRATES

One way of guessing the intelligence of an animal is to compare the weight of the animal's brain with the weight of the animal's spinal cord. Scientists have made many such comparisons among animals. A fish's brain weighs less than its spinal cord. A cat's brain weighs four times as much as its spinal cord. A cat is much more intelligent than a fish. A monkey's brain weighs about eight times as much as its spinal cord. A human being's brain weighs more than fifty times as much as his spinal cord. As life goes from simpler animals like snakes to more complicated animals like monkeys, the weight of the brain increases as compared to the weight of the spinal cord.



VERTEBRATES

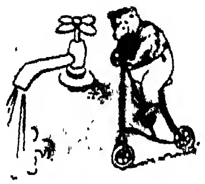
Things to Do



1. Do you think the animals in the experiment described on p. 165 learned to tell the difference in the colors of the squares? Look at the drawing on that page and see if there are other things the animals might notice besides color that would help them get the food. Plan an experiment to test your idea.

2. Tom rewarded Chipper with scraps of food when Chipper did what Tom wanted him to do. Suppose you wanted to teach your dog to work for another kind of reward. Suppose you wanted to teach him that your saying "good dog" and patting him is also very pleasant. Write the steps you would take to teach him.

Things to Talk About



You learned that animals must want something in order to learn. Are people always the same as animals in this respect? What did you want when you learned to sew or to play baseball? What did you want when you learned to multiply? Did you want someone's approval? Did you want to escape punishment? Did you want to be able to do something well?

If You Want to Find Out More

1. So far, you have read mostly about the training of pets. Do you think an animal like a caterpillar can be trained? Make a plan for an experiment to find out. Caterpillars eat leaves, so you can use a leaf as the reward part of your experiment.

2. Some insects, such as ants or bees, live together in colonies. They build very complicated homes and divide up the work so that different insects do different things. Scientists think these behaviors are not learned.

Can you think of some things that birds do that they have not learned? How about birds flying south, or building nests? Observe birds carefully for a day or two. Then report on things they can do that you think are not learned. Check with an encyclopedia.

TEACHING PETS WHAT NOT TO DO

Sometimes we have to teach pets what *not* to do. You don't want your dog to climb onto the couch. At least, your mother doesn't! You don't want him chewing the carpet or your best shoes. If he does these things, you want him to change his behavior. You want him to learn not to do something he now does. You can use what you know about learning to teach him.

Let's go back to the Jones' Chipper. You remember Chipper had learned to scratch on the screen door when he wanted to go back into the house. When the Joneses saw what was happening to the screen, they wanted Chipper to stop. How could they teach him not to scratch?

Here are some things they could try. Which one do you think is best?

They could stop opening the door for Chipper when he scratched.

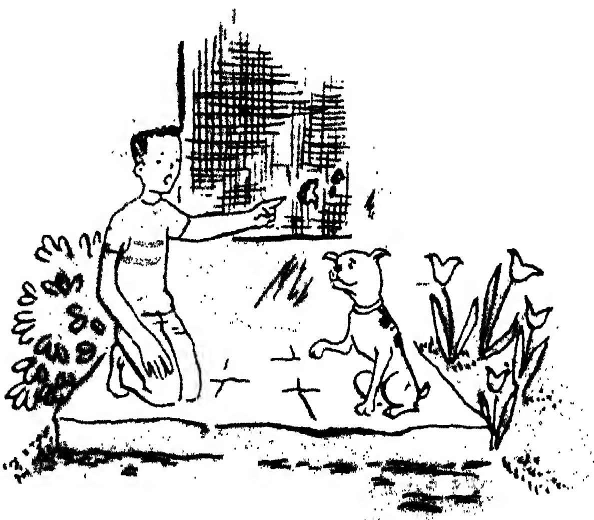
They could punish Chipper for scratching.

They could teach Chipper a different way to get what he wanted.

Psychologists have found out that the first way is not a very good way to break an animal of a bad habit. Even if the Joneses stop letting Chipper in when he scratches, he still won't learn not to scratch.

The second way, punishing Chipper for scratching, will teach him under certain conditions. Do you remember why Chipper came when Tom called him? He found out Tom's call meant a reward—food. In the same way, Chipper can find out that whenever he scratches on the door, something unpleasant will happen to him. Suppose every time he scratches the screen someone swats him with a folded newspaper. The swat should not be too hard. It is the noise of the swatting that will be punishment for him. What will he find out?

Of course, the swatting must come right after the scratching. Tom learned this when he decided to teach Chipper not to scratch the screen. At first Tom had to search for a newspaper each time he heard Chipper scratch. Then he had to fold it up. Then he ran out the door so fast that Chipper was scared away. By the time Tom caught



him and swatted him, it was too late. Chipper didn't know what he was being punished for.

If you use punishment to break your pet of a bad habit, be sure to punish him right after he does the wrong thing. Whenever *you* are punished, you probably remember what you're being punished for, even though the punishment doesn't come immediately. But most pets don't.

Can you solve Tom's problem for him? How could Chipper learn to connect scratching on the door with something unpleasant?

One word of advice. Don't make the punishment too severe. And don't use punishment too much. If you train a dog only by punishment, he will probably always fear you—just as you would fear someone who always punished you. The dog would always wonder when the next punishment was coming. He might be obedient, but he would also be a very fearful dog. And fearful dogs make poor pets.

Psychologists have found that dogs learn best when they feel their master likes them. Dogs that are liked try hardest to please. It's the same way with people, too.

Reward your dog for good behavior. If you have to, punish your dog for behavior you dislike. If you use both these methods, punishing only when you feel you must, you will train your dog successfully. And your dog will not fear you.

Things to Do

Tom tried to teach Chipper not to scratch the screen by swatting him. Plan another way that Tom might teach Chipper to get back into the house without scratching the screen. You will have to use the four parts to learning: wanting something, noticing something, doing something, getting something. Explain how you would use the four parts in your plan.

Things to Talk About

1. Have you ever tried to teach your pet to do something without success? What did you do? Why do you think your way of teaching failed? Which of the four parts to learning do you think went wrong?

2. If you know someone who has trained a pet, ask him to explain how he did it. Compare his method with the way Tom trained Chipper to come when called.

TEACHING A BIRD TO TALK

Let's imagine that you own a bird that can learn to talk. Parrots can learn to say a few words. So can myna birds and parakeets. Of course birds never learn to talk like people. They don't make up new sentences to express new ideas. Talking birds learn only to repeat a few words over and over again.

Let's imagine you own a parakeet and would like to teach it to say, "How are you?" What would you do?

One way might be to repeat, "How are you?" to the parakeet over and over again. Would this be a good way? Does the parakeet want something? Does the parakeet get something? Are the

de la Vega, National Audubon Society

Above: A parrot

Right: A parakeet

four parts to learning present here? What is missing?

Here is a better way. First, be sure to start when the parakeet is very young. This is important. Most older birds have learned that they can get what they want by methods other than talking.

Every time that you feed the young parakeet, hold him in your hand as you give him the food. And before you give him each bit of food say, "How are you? How are you?" Do this for several days. By and by the bird will know that the words, "How are you? How are you?" are followed by food.

After many lessons, hold the parakeet in your hand but don't feed him. If he is very hungry, he may make a noise that sounds just a little like, "How are you?" When he makes this sound, reward him with a bit of food. The parakeet will then try to say, "How are you?" whenever he is hungry. He knows that food comes when he makes that sound. He will say it better and better. You will have taught your parakeet to talk!

You should hold the parakeet in your hand whenever you give him food. Then he will notice that *you* make him feel good. Soon he will want to have you near his cage, even without food.

The parakeet also learns that when he says a few words, you come to the cage. When he learns this, the parakeet will try to talk often. He will keep trying to say a few words to make you come to the cage.

You can then teach your parakeet new words without using food. The reward is just to have you near his cage. This method of teaching a parakeet to talk succeeds only when the parakeet wants you near by. A bird will learn to talk only when these four things happen:

1. When it wants something. (Food, petting)

2. When it notices something. (That the words, "How are you?" or any other words are followed by food or petting)

3. When it does something. (Tries to say, "How are you?")

4. When it gets a reward. (Food, petting)

HOW DO PEOPLE LEARN?

You have found out how you can train animals. You have found out how animals learn. You have also read that people learn the same way that animals learn. Let's think about something you may have learned recently. Let's see whether the four parts to learning were present. Suppose you have recently learned to use a baseball bat. Let's compare the way you learned to use the baseball bat with the way Chipper learned to get inside by scratching on the screen.

First, you must have wanted to learn to use the baseball bat, just as Chipper wanted to get inside the house. The first part of learning is to *want* something. You may have had one or many different reasons for wanting to learn to use the baseball bat. One reason may have been simply to be able to play baseball better. Or to become a better player than one of your classmates. Or to be considered a good player by your friends. Perhaps you had still other reasons.

Then once you wanted to learn, noticing something is the second part. Maybe you noticed that when you held your hands close together on the bat instead of far apart, you could hit the ball more often. Or perhaps you noticed that the two best hitters on your team held their hands close together. Or perhaps someone pointed this out to you and you tried it. Do you remember what Chipper noticed when he was learning how to get inside the house?

Once you noticed that the new way of gripping the bat helped you hit the ball more often, you held the bat that way every time. *Doing* something is the third part to learning. Chipper, you remember, scratched on the screen once he noticed that scratching made someone open the door.

The fourth part of learning is the reward. Your reward came when you hit the ball and your team told you how good you were. This was your reward, just as Chipper's reward was to be let into the house.

You may think that your learning takes place chiefly at school. This is not true. You learn every day from your friends, from your family, from watching television. You learn on the playground and at home. But whenever you really learn, that is, when you really change the way you act, you use the four parts to learning.

Noticing the Right Things

You have probably learned how to use an index in a book. But have you ever looked up a topic and found many pages listed? Perhaps you have looked up *electricity*. You found: electricity, 21, 33, 44–51, 63, 175. If you wanted a lot of information on electricity, on which pages would you look? What is the clue that you notice? You can learn to use an index better if you notice the right things

Detroit Public Schools

A good learner is in many ways like a good detective. Both notice things. Both are on the lookout for clues that will help them to know the right thing to do. The next time your teacher is explaining something, see what a good detective you can be. See how many clues you can find in the explanation that will help you to remember what to do.

Here is something for you to practice on. Here are the answers to the multiplication facts by 9.

9 18 27 36 45 54 63 72 81

How many different things do you notice about these answers? Which will help you to remember the right answer? Can you explain what you have found out?

Looking for meanings in what you notice is important. Let's go back to two new words you have learned—*vertebrates* and *invertebrates*. One word means animals that have a backbone. The other word means animals that do *not* have a backbone. Do you remember which is which? You will never get them mixed up if you think of the meaning of *in*. *In* as a prefix has several meanings. One of the meanings is *not*. *Inefficient* means not efficient. *Indirect* means not direct. *Inconvenient* means not convenient. Now can you tell which word means animals that do *not* have a backbone?

Most Habits Are Good Habits

Sometimes we learn things so well we can do them without thinking about them. We call these behaviors habits. We learn habits the same way we learn anything else. We use the four parts to learning. But the *doing* part is done so often, we don't think about it any more.

Everyone has habits. You probably always begin the brushing of your teeth on the same side of your mouth each day. You probably have a habit of always putting on the same shoe before the other every morning. You button your sweater the same way each time you put it on. Everyone does some things every day without even thinking about them. He does them by habit.

Most habits are useful. Suppose you had to stop and think about what you were doing every time you buttoned your sweater, or put on your shoes, or brushed your teeth. While you do these things, you can be thinking of other things. Habits help your day run smoothly.

But just as you have habits that are useful, you probably also have habits that are unpleasant and annoying. These habits may not annoy you. But they may annoy other people.

What are some habits that annoy others? Some people you know may have a habit of holding their hands in front of their mouths when they speak. Other people may have a habit of biting their nails. Still others may have a habit—annoying to mothers—of leaving clothes scattered around.

It is easy to understand why some habits annoy others. You can hardly understand what a person is saying when he keeps his hand in front of his mouth. Leaving your clothes around makes extra work for someone. But some habits annoy others because they have learned that these ways of behaving are not "nice." Biting nails, chewing with your mouth open, chewing on pencils and other things, seem unpleasant to many grownups. We make life more pleasant for those around us if we try to avoid doing things that annoy others.

Changing Habits You Don't Like

We change our habits all the time. When you were two or three, you probably had the very good habit of holding your mother's hand when you were crossing a busy street. This habit disappeared as you grew older. You may not have noticed that you were changing your way of crossing the street. You learned new habits which, little by little, took the place of the old one.

Are there some habits you had last year that you no longer have? Did these seem to disappear without your doing much about them?

You may have some habits that you would like to change. Perhaps you bite your nails. Perhaps you would like your nails to look better. How can you change the habit?

Changing habits is a learning job. You must learn not to do a certain thing. You must learn to do something else instead. The four parts of learning are important here, too. Wanting to change the habit is the first part.

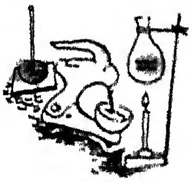
The reason it is so hard to change a habit is that once a habit is formed, you no longer notice what you do. If you bite your nails, you probably don't notice when you do it. If you leave your pajamas in the middle of the floor, you may not even know it. If you make careless mistakes in arithmetic, you may not be noticing the right things.

We sometimes make up our minds to change a habit. Then, a few minutes later, we catch ourselves doing the very thing we decided to stop doing. If every time this happened, a bell would ring, it would be easy to change. We could stop ourselves and practice doing something else.

To change a habit, it is important to notice what you are doing. There is no easy way to do this. Sometimes, in a subject like arithmetic, you have to make yourself go more slowly and think about each step. If you are practicing better posture, perhaps you can get someone to remind you every time you slump.

If you have a habit you want to change, can you make a plan for changing it? What can you do to notice the old habit? What new way of behaving will you practice in its place? Perhaps your parents, your teacher, or a friend can help you with your plan.

Things to Do

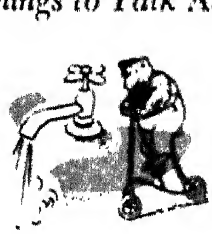


1. If you have a talking bird, try to teach him to say a new word. Use the methods you have read about in this unit. Report to your class about your attempts.

2. How are homing pigeons able to carry messages over great distances? Do they learn this behavior? Or are they born with it? Look up *pigeons* in an encyclopedia or try to get a book on pigeons to find out.

3. If you have a pet, make a list of all the things he can do that he didn't have to learn. How do you know he didn't learn them?

Things to Talk About

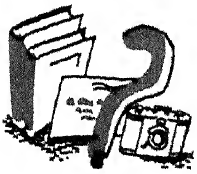


1. Is there a school subject you like very much? Why do you like it? How do you think you get these feelings about it? How do you think you can change your feelings about a subject that you don't like?

2. Can you think of some things you can do that you did not have to learn? What are they?

3. Have you ever gone fishing? Do you think fish can learn? What have you seen fish do that you think they learned?

If You Want to Find Out More



Here is a short way to multiply that may be new to you. See if you can learn it.

```
 156
 x24
```

Step A: $4 \times 6 = 24$
Write 4 ones and carry 2 tens.

```
   2
 156
 x24
 ---
   4
```

Step B: 4×5 tens $= 20$ tens
2 tens $\times 6 = 12$ tens
$20 + 12 + 2 = 34$ tens
Write the 4 in the tens place and carry 3 hundreds.

```
  32
 156
 x24
 ---
  44
```

Step C: 2 tens $\times 5$ tens $= 10$ hundreds
4×1 hundred $= 4$ hundreds
$10 + 4 + 3 = 17$ hundreds
Write the 7 in the hundreds place and carry 1 thousand.

```
 132
 156
 x24
 ---
 744
```

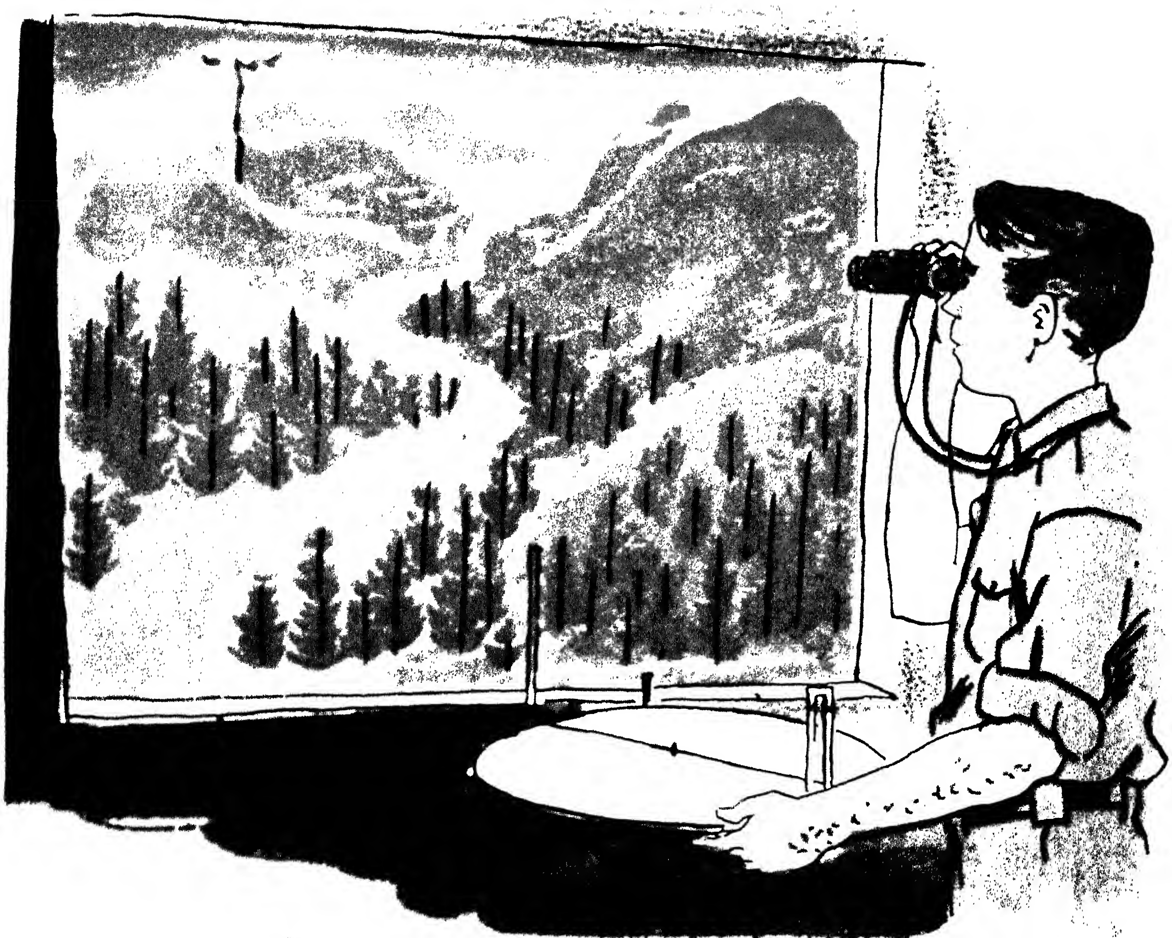
Step D: 2 tens $\times 1$ hundred $= 2$ thousands
$2 + 1 = 3$

```
  132
  156
  x24
 ----
 3744
```

Study this explanation until you understand it. What things are important to notice in the explanation? When you think you have learned the new way, try this example:

```
 235
 x45
 ---
```

See if you can do it without writing out the steps. Check your answer by multiplying the long way.



8 Managing Wildlife

About "*Managing Wildlife*"

Does *managing* wildlife seem like a funny title to you? Perhaps you think of the word *managing* in connection with other things. Perhaps you have heard of someone managing a baseball team. Or perhaps you know someone who is manager of a store. What jobs does a person have to do in managing a baseball team; in managing a store?

Wildlife also needs managing if we are to make the best use of it. Some animals that do not live with man need to be protected so that they will not die out. Some need to be controlled so that there will not be too many of them. Managing wildlife is planning for the control, protection, and use of wildlife.

This unit on wildlife managing will help you to learn more about our wildlife and to understand such questions as these.

Why is wildlife important to us?
How have we failed to use our wildlife properly?
What is being done to manage our wildlife today?
What can each of us do to help?

WHY IS WILDLIFE IMPORTANT?

Try making a list of the ways wild animals are useful to you. Do you use some for food? Do some protect your garden? Are there some you just like to watch? Compare your list with a friend's. Can you make a list of twenty or thirty helpful wild animals?

Wildlife of many kinds is used for food. In fact, every kind of animal has probably been eaten at some time by human beings. You may have eaten wild duck, deer, and quail—as well as salmon and oysters. But even porcupine and muskrat have been eaten by people.

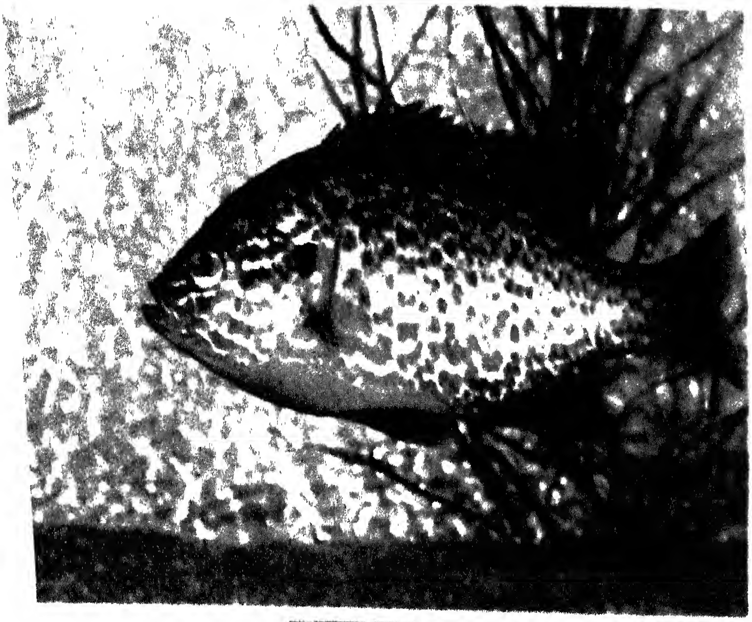
At one time, the main reason for killing wild animals was to get food. But today, many people hunt animals just for the sport. Of course they eat some of the animals they kill, but the main purpose of hunting animals today is not for food.

Fish

Today, more fish is eaten than any other wildlife. Man has been catching fish for thousands of years. He has speared them, hooked them, netted them, trapped them, even caught them with his bare hands. In some places man has trained large birds to catch the fish for him. In different parts of the world all these methods are still used.

Fish are not the only wildlife from the ocean that people eat. Oysters, clams, shrimp, lobsters, and crabs are also eaten in large quantities. Like beef, lamb, and pork, these animals are good sources of protein. But they are easier to raise than livestock.

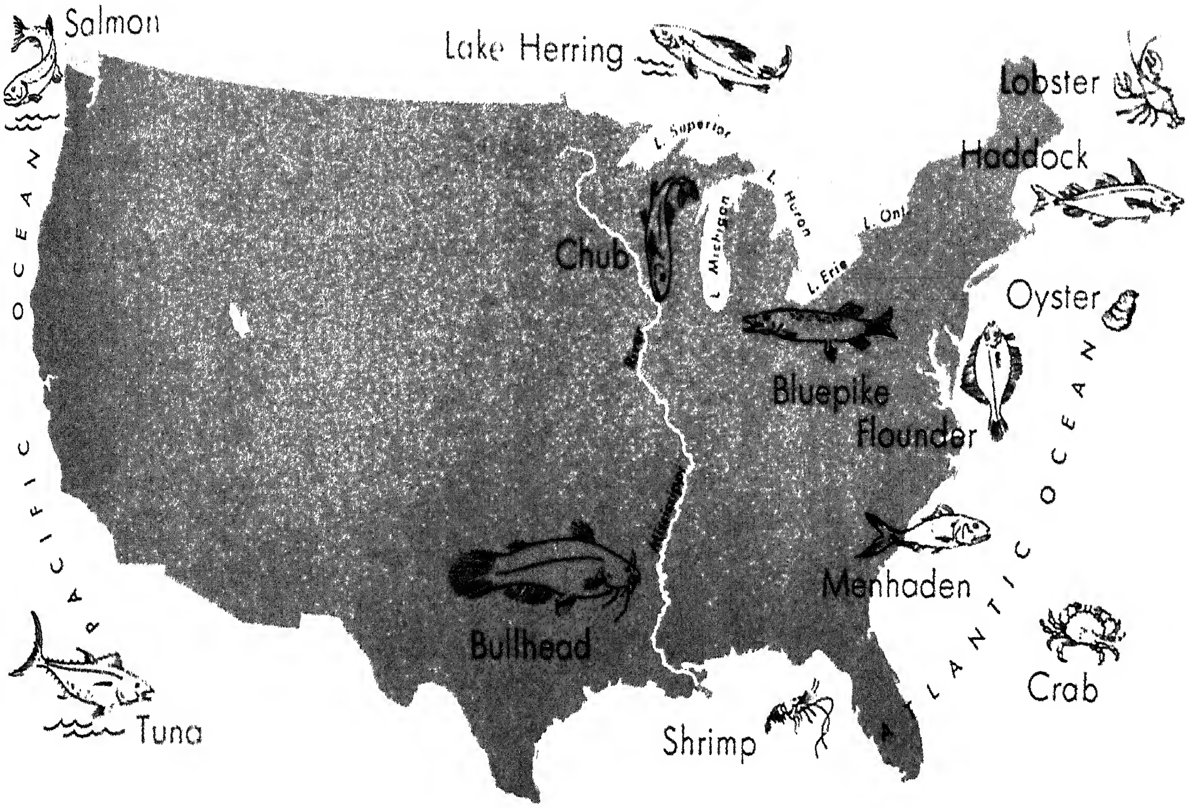
For example, it takes four acres of pasture land and three years to produce one steer—about 600 pounds of useful protein. Four acres of oyster beds in Chesapeake Bay can produce



A bright orange and yellow sunfish and a trout. Both fish live in fresh water. They are caught mainly for sport.

W. T. Davidson, National Audubon Society

OUR IMPORTANT FISH AND SHELLFISH



32,000 pounds of protein in three years. This is as much meat as 50 steers! Many scientists believe we will depend upon the sea for food even more in the years to come.

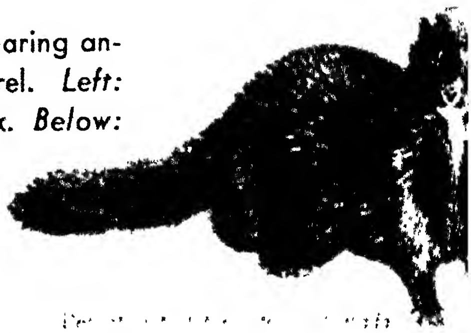
As the population of our country has grown, more and more fish have been used. In order to catch more fish, commercial fishermen are using new scientific aids. For example, schools of fish are spotted from an airplane. Sometimes the fish themselves can be seen. At other times the color of the water will show that there is a school of fish below. When a school is spotted, a radio message from the plane tells the fishermen where the fish are.

Fish are also located by an instrument that sends vibrations out through the water. These vibrations are like sound waves, except that you can't hear them. You know how sound waves bounce back from hillsides as echoes. These underwater vibrations bounce back, too. They bounce back from rocks, other boats, and from schools of fish. The instrument picks up the echo. From the echo it is possible to tell whether a school of fish is near and where the school is.

U. S. Fish and Wildlife Service

U. S. Fish and Wildlife Service

Some important fur-bearing animals. *Above:* Squirrel. *Left:* Raccoon. *Right:* Mink. *Below:* Muskrat



U. S. Fish and Wildlife Service

Wildlife for Furs

Earlier in this book you read about some of the ways plants and animals adjust to changes outside their bodies. One way we adjust to changes is to wear heavier clothes in the winter. Animals adjust to winter in other ways. Some animals have fur. Their fur is made up of fine, short, woolly hairs and longer, coarser hairs. You can't see the fine, short hairs unless you brush the longer ones aside. As winter comes, many more of these fine, woolly hairs grow to keep the animals warm. Then when spring comes again, many of these fine hairs fall out. This is what is happening when your dog sheds his coat.

For thousands of years man has used animal furs for clothing. Today we make most of our clothing from other things. Even so, we still use many furs. In the United States and Alaska, between eight and ten million animals are trapped or shot each winter for their fur. Over half of these are muskrats. About one-tenth of them are raccoons. Then come squirrels, mink, coypus, and about twenty other animals. Some of them are so rare that no more than twenty or thirty are caught in one winter.

Besides the animals that are shot or trapped, many mink and fox are now raised on fur farms.

Some Animals Kill Pests

All living creatures have many enemies. Insects are eaten by frogs, toads, salamanders, birds, and other insects. The frogs, toads, and salamanders are eaten by fish, turtles, snakes, and many kinds of birds. The smaller birds are eaten by hawks and cats.

Birds eat harmful insects in our forests and farms. They eat beetles, wasps, ants, flies, caterpillars, and plant lice, to name just a few pests. Without birds, there would be more insect damage to our trees, crops, and other plants. Sometimes a single bird eats more than a quart of insects in one week. How many flies—or corn borers—do you think can fit into a quart bottle? You can see how valuable birds are as garden and farm helpers.

Now answer these questions. What may the number of cats in your community have to do with the amount of insect damage to the gardens? What do you think can be done to protect birds from cats?

Do you think of snakes as helpers? Snakes eat many field mice. So do owls. If snakes and owls did not eat as many mice as they do, there would be many more mice eating the farmer's grain. Bats eat flying insects. Coyotes eat jack rabbits. All these animals are useful because they help keep down the number of pests.

Enjoying Our Wildlife

As you have read, our wildlife provides much of our food and some of our clothing. But for many people it also provides pleasure. Many people put bird houses and bird feeding stations in their yards and around their farms. They like to attract birds. Birds not only eat insects, but they are interesting to watch.

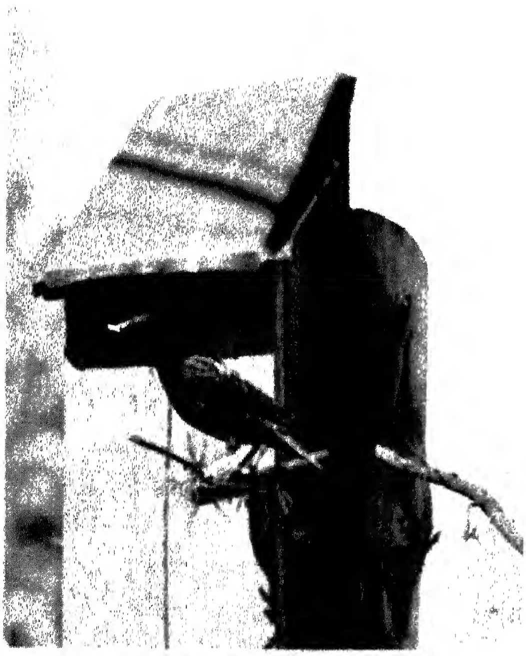
Identifying birds and studying their habits is a hobby for many people. These people like to observe how and when different birds build their nests, how they raise their young, and how they get their food. Many people use field glasses or small telescopes, which

Top to bottom: **The scarlet ibis, the roseate spoonbill, and the snowy egret, as they look in flight. These birds can be seen in southeastern United States.**

American Museum of Natural History

American Museum of Natural History

The American bald eagle. This bird, which is a symbol of the United States, has become very rare.



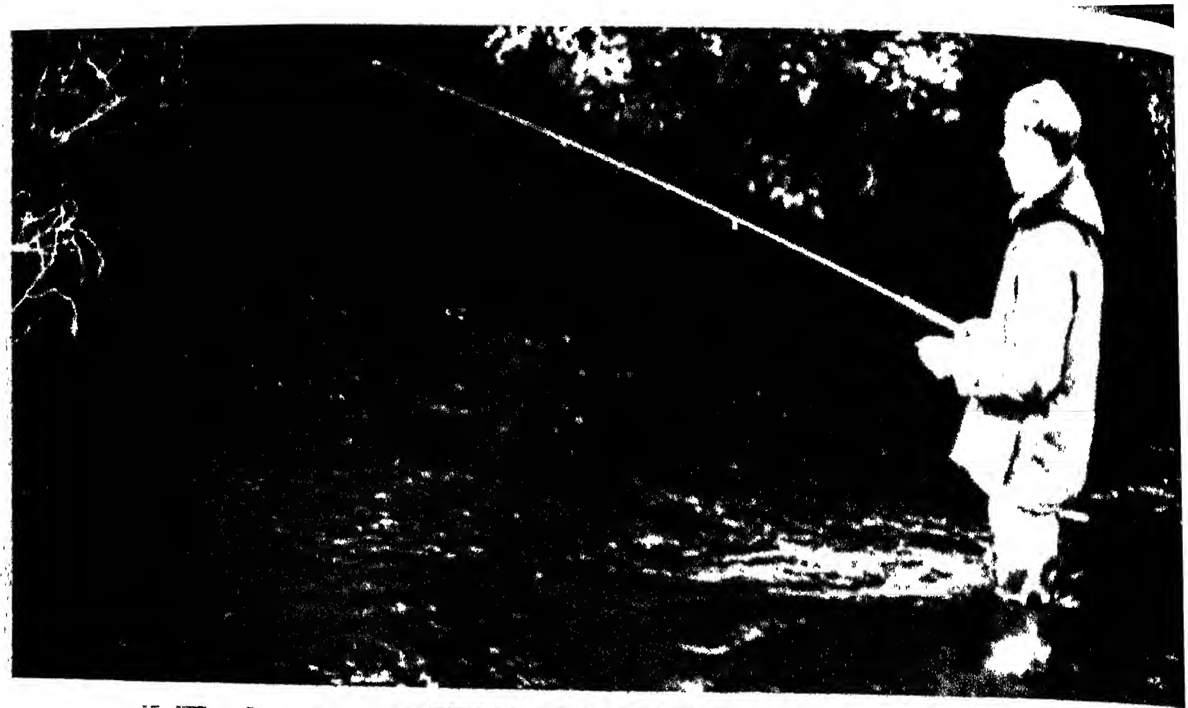
U. S. Fish and Wildlife Service

A starling bringing food to its young

make things look bigger. With field glasses or a telescope, you can watch birds and animals that are far away without being seen by them.

Some people take pictures of wildlife for a hobby. Perhaps you know of someone who has taken unusual pictures of birds. Such people are able to share interesting outdoor experiences with their friends by showing their pictures.

Hunting and fishing are other wildlife hobbies that many people enjoy. Like most hobbies, hunting and fishing require skill. You must be a good shot, or you must be able to cast your bait to just the right spot. Many people enjoy being able to do these things



Above: Fishing for trout in a Michigan stream. *Left:* A pair of quail in Illinois. Quail hunting is a popular sport.

well. Hunting and fishing also take people outdoors. The exercise they get makes them feel good, too.

To be a good hunter or fisherman, a person must learn about the habits of different animals, including fish. He must learn the best kinds of places to look for them. He must learn what they like to eat, and the kinds of homes they make. He must learn to recognize the kinds of tracks different animals make. Learning these things makes his hobby more interesting.

Sometimes our wildlife is better off because people hunt and fish. For example, in some places deer become quite numerous. Then, when a very bad winter comes, they can't all get enough food to eat. Thousands of them become so weak from hunger that they get diseases and die. When they can't get the food they are used to, they eat the bark from small trees. Hunting deer in such places keeps them from becoming too numerous. It also helps to protect our forests.

Fish grow only when they can get enough food. If they don't get enough food, they stay small all their lives. There is hardly ever enough food in a pond, lake, or stream for all the fish to eat as much as they need. But if some of the fish are caught every year, the other fish can get more food and grow larger.

As you see, our wildlife makes many pleasant hobbies possible for millions of people. But there are some things outdoors which are not so pleasant. You have already read about poison ivy on pages 139–140. There are bees and wasps whose stings are very painful. There are many other insects that bite people. There are poisonous snakes in some parts of our country. There are sharp rocks, pointed limbs, and thorny plants that can cause injuries.

People who enjoy wildlife hobbies should know first aid. They should carry a first aid kit when they are hunting, fishing, hiking, or camping.

Avoiding Gun Accidents

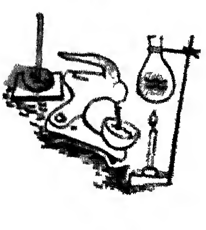
Guns cause many accidents each year. Most of these accidents are caused by people who have not learned the right way to handle guns.

If you are interested in hunting, perhaps some day you will have a real gun of your own. If you do, you will learn how to use it safely. You will certainly not use it the way you used your toy guns when you were small. You will certainly not use it the way you see people on TV use guns.

Real guns are dangerous. People who have not been taught how to handle them safely should never pick one up.

One of the best hunters in Texas says, "At my house every gun is *always* loaded." Why do you suppose he says that?

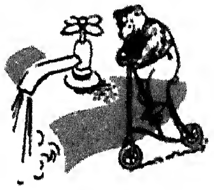
Things to Do



1. Visit a large food store and make a list of the foods you can buy that come from the water. Besides looking in the fish counter, be sure to look in the frozen-food section and on the canned-food shelves. Try to find out where each kind comes from. Maybe this information is on the package. Maybe you can find out by writing the company that packaged it.

2. Make a wildlife map of your state. You can begin by making a large outline map of your state for your bulletin board. Around the map put pictures of the important wildlife found in your state. You may want to draw these pictures. Along with each animal you can draw a picture of the kind of track it makes in the mud or snow. What can you write on the outline map to remind people how the wildlife of your state is used? You can get the information you need from your State Conservation Department.

Things to Talk About

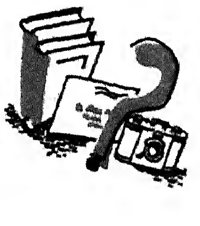


1. How may different kinds of fish and other wildlife that live in the water have you eaten?

2. You have read that owls help the farmer by keeping down the number of mice. Suppose all the mice were destroyed. What might happen next?

3. Since a few snakes are poisonous, some people want to kill every snake they see. What might happen if all the snakes were killed?

If You Want to Find Out More



1. Are any animals trapped for fur in or near your community? If so, what animals? How do the people who trap the animals preserve the furs? Where do they sell the furs?

2. Where do people from your community go fishing? What kinds of fish do they catch? What kinds of bait do they use?

3. You have read that many insects are harmful to plants. But some are also helpful to plants. In what way are they helpful to plants?

4. Nearly half the fish caught in the ocean around the United States are never eaten. They are used in many other ways. Find out some of the other ways they are used.

U. S. Fish and Wildlife Service

A herd of bison in Montana

WILDLIFE IS LIMITED

Once there were large herds of bison living on the plains of our country. Many people call them *buffalo*, but scientists speak of them as *bison*.

For hundreds of years before the settlers came to the West, the Indians had hunted these bison. They depended upon the bison's flesh for food. From the bison's skin they made their shirts, pants, shoes, robes, blankets, tents, shields, and even boats and sleds. From the bison's insides they made their bow strings, water bags, and "medicine." Hardly a scrap of any bison they killed was ever wasted.

Because the Indians depended on the bison for so many things, they were careful never to kill more bison than they needed.

Early settlers and travelers in the West commonly saw enormous herds of bison. The plains were sometimes crowded with them. The settlers thought there were so many bison that nothing could ever happen to reduce their numbers. But they were wrong. At one time there were more than 50 million bison in America. What happened to them?

Perhaps you already know the story of our American bison. They were shot by the hundreds and by the thousands. The early settlers killed them for food. Later on they were shot mostly for their skins, which were shipped back east by the thousands. Many thousands more were killed just for "sport," and their bodies were left to rot on the plains. By 1890 there were only about 500 bison left in the United States.

The Passenger Pigeon

Some kinds of animals have disappeared because they could no longer find enough food. A few kinds were killed in such great numbers that they were wiped out. One such animal was the passenger pigeon. At one time this bird was even more common than the pigeons you see today. But no one will ever see a live passenger pigeon again.

Passenger pigeons often ate crops and were therefore considered pests. But they were also helpful since they ate harmful insects.

Passenger pigeons lived mostly in forests, nesting high in the trees. As the forests were cut down, the birds found fewer and fewer places to raise their young. In addition to that, the meat of these birds was good, and the pigeons were easy to shoot. Fifty at a time were sometimes shot in a single tree. Sometimes people shot them just for fun and didn't eat them. Soon, instead of billions, there were millions. Then thousands. Then a few hundred. Finally, you had to go to a zoo to see one. Then, in 1914, the last passenger pigeon in the whole world died.

Passenger pigeons

U. S. Fish and Wildlife Service
From a painting by L. A. Fuertes

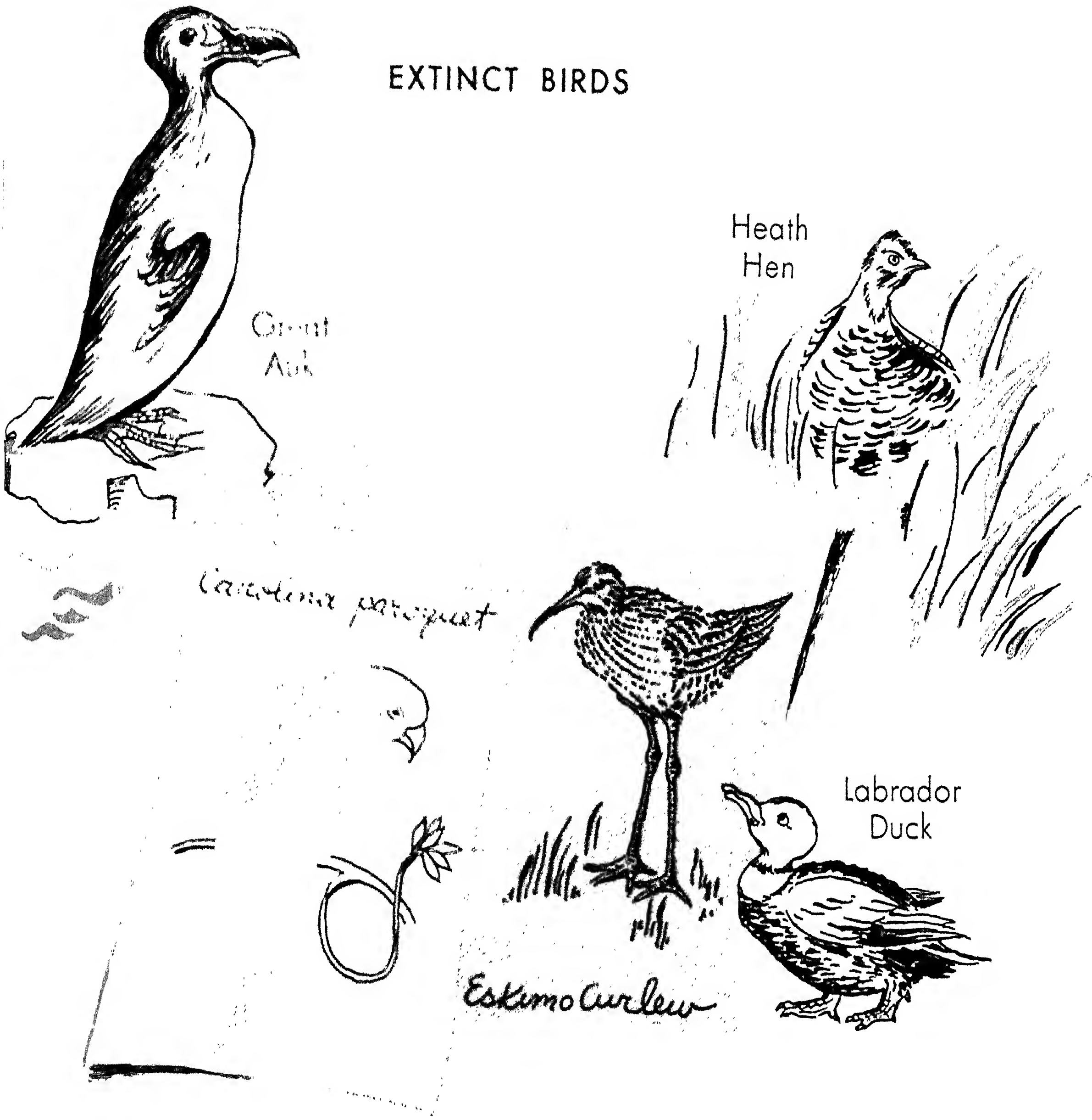
There are other animals you will never see. When animals die out, we say they become **extinct.** The birds shown on the next page once lived in this country. They are now extinct.

Hunters killed very many of them. In addition, their nesting places were cut down, and their eggs were destroyed.

Some animals—like frogs—lay thousands of eggs at a time. If some of them are destroyed, there will still be many left to become frogs. But birds lay only a few eggs at a time. If these do not hatch, there will be no new birds.

Many of our waterfowl are in danger, too. Wild ducks and geese are the waterfowl people hunt most. Every fall and winter, thousands of people hunt these birds. In the fall, you may see flocks of these birds flying south for the winter.

Most waterfowl spend the summer months in the northern part of United States and in southern Canada. When



fall comes, like many other birds, they fly to warmer parts of the world. Scientists still do not completely understand how the birds know when to leave. Nor do they understand how the birds can find their way over such long distances.

Some of our waterfowl fly as far south as Central or South America. In the spring they fly north again to nest in swampy places. But over the years many swampy places have been drained to make room for farm land and for buildings. Today our waterfowl find fewer nesting places than they used to.

As these swampy places were drained, our population grew. More people became interested in hunting waterfowl. You can guess what happened to many of the waterfowl.

U. S. Fish and Wildlife Service

The Green Turtle

Certain ocean animals, such as the green sea turtle, have been nearly wiped out, too. When Columbus came to America, he saw many of these turtles in the warmer ocean spots. Ship crews in colonial times often ate these turtles. When other food ran out or spoiled, it was usually easy to catch green turtles. Later on, many were caught and sold to make soup, particularly in the South. They are still caught and sold in large numbers. Today you can get canned green turtle soup in many grocery stores.

Like all animals, green turtles must be able to find food, produce their young, and protect themselves from enemies. Otherwise they will die out. There is still as much food for them as there ever was—a whole ocean full. But their many enemies, including man, have killed them off faster than the turtles could produce their young.

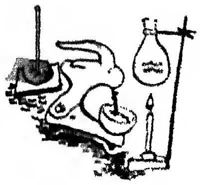
To produce their young, these huge turtles come ashore on the warm islands of the West Indies and lay eggs on the beach. But many houses have been built on the beaches in recent years. Now there are buildings in many places where there was once sand—and the turtles find fewer places to lay eggs. Unless we can protect the green turtle, it, too, will become extinct.

Other Animals Are in Danger, Too

It's not just on the large plains, in the great forests, or in the ocean that wildlife has found it more difficult to live. Whenever a wooded lot near your home is cut down to build a house, some wildlife is forced to move.

In a later unit you will find out how we get clean water for drinking and washing. But wildlife must have clean water, too. If garbage and sewage are dumped into streams, the streams become **polluted.** Do you know what happens to the fish then?

Things to Do

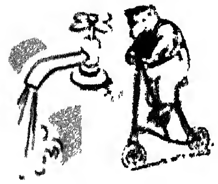


1. Make a list of all of the different kinds of animals you can find in an empty lot near your home. What happens to each animal when a house is built on the lot?

2. Make a plan for helping other children in your school find out about the usefulness of wildlife. What different kinds of posters could you make? What kind of talks could you give? Could you write a short play about wildlife for an assembly program? Your class might prepare an exhibit on the usefulness of wildlife.

3. Find out from some of the older people in your community what animals used to be more common where you live. What has happened to these animals?

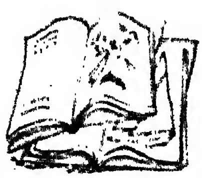
Things to Talk About



1. Why shouldn't everyone be allowed to use the wildlife that lives on his own property in any way he wants to?

2. What are some of the hunting and fishing laws in your state? Discuss the reasons for these laws.

Things to Read About

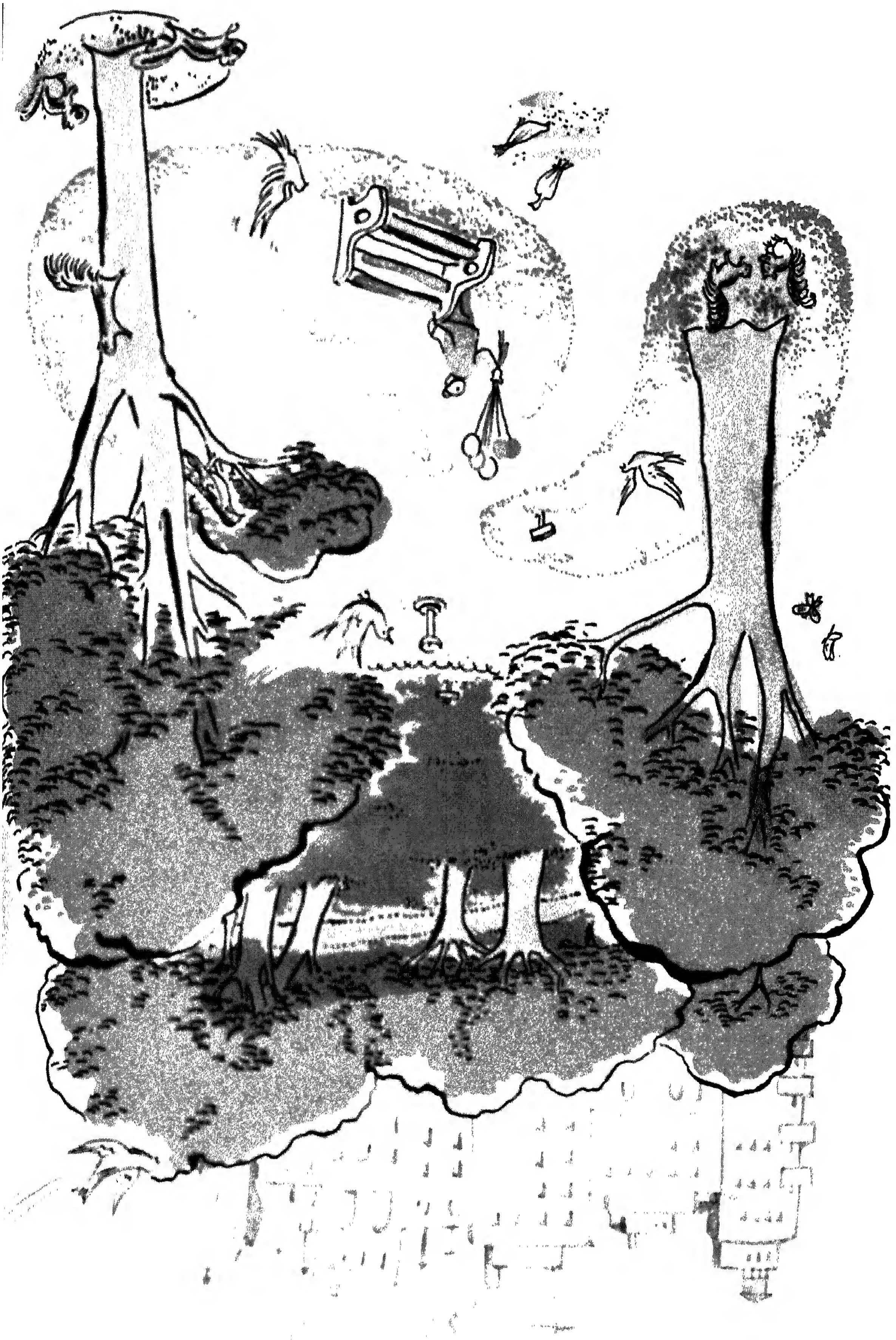


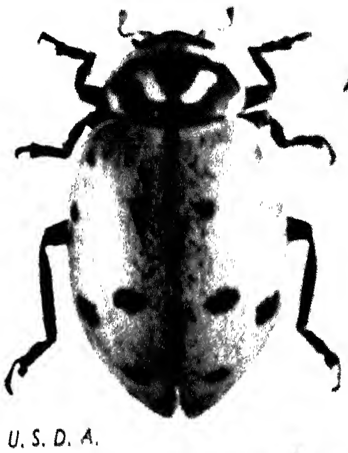
Write to your State Conservation Department. Ask it for pamphlets about animals that are protected in your state. Find out how these animals are protected. Is your State Conservation Department trying to cut down the number of any animals? Why?

If You Want to Find Out More

Look up one of these subjects and report about it. You may have to look in several different books.

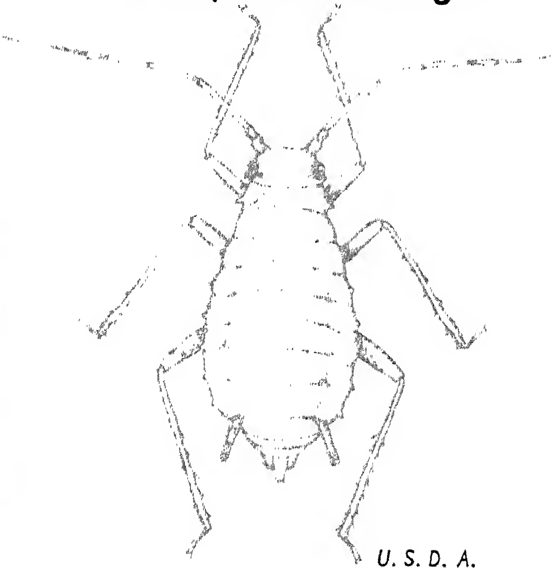
a. The use of bird feathers for ornaments
b. How railroads affected bison
c. How building dams on certain rivers has affected our supply of salmon
d. How to train a hunting dog
e. John James Audubon





A ladybird beetle, enlarged

U. S. D. A.



An aphid, much enlarged

U. S. D. A.

A shrew

U. S. Fish and Wildlife Service

WILDLIFE NEAR YOUR HOME

If you live in the suburbs or the country, you know that there are many different kinds of wild animals near your home. Field mice, rabbits, woodchucks, chipmunks, snakes, deer, muskrats, and skunks live in the woods, fields, and swamps.

Even if you live in the city, you see useful animals. Birds live in the city parks; so do squirrels. You see sparrows and pigeons right on the streets. And, of course, there are hundreds of different insects—even in the most crowded cities.

Many of these common animals help you. You might ask, "What good is a ladybird beetle? Or a shrew? Or a praying mantis?" Yet every one of these animals is important to people. Let's see how.

Ladybird beetles eat certain tiny insects that damage plants. Small lice, called aphids, suck juices from plant stems. Aphids are the favorite food of ladybird beetles. Because of the ladybird beetle, you have healthier plants.

You may never have seen a shrew. It is a night animal that lives in underground tunnels. Shrews eat hundreds of insects and small mice every day. The praying mantis is another valuable animal. It, too, eats harmful insects.

This multiflora rose hedge provides a fine home for wildlife. U. S. D. A.

Attracting Animals

You can attract animals if you provide a place where they can get food, produce their young, and protect themselves from their enemies. One way to do this is to build a fence made with shrubs instead of wood or wire. Such a fence serves both as a boundary and as a home for valuable animals. More and more farmers and home-owners are building this type of fence.

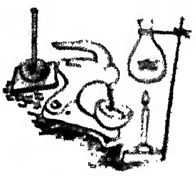
Birds use shrubbery fences for nesting. Ladybird beetles and shrews are also attracted to them. If a farmer grows enough of these shrubs, there will be fewer insects to harm his crops. Most people like birds near their homes, not only because they eat harmful insects, but because they are very pretty.

Animal Feeding in Winter

Animals use a number of different plants for food through the winter. Birds eat the seeds of many different plants if they can find the plants. Deer eat the buds from shrubs and trees. They will also eat acorns and other large seeds. Rabbits eat the bark of young trees.

After a fresh snow you often find animal footprints in the snow near bushes or young trees. The tracks show that animals were there—probably hunting for food. Some people can identify birds and other animals from their snow prints. If you find them, you will know which wild animals search for food near your home during the winter.

Things to Do



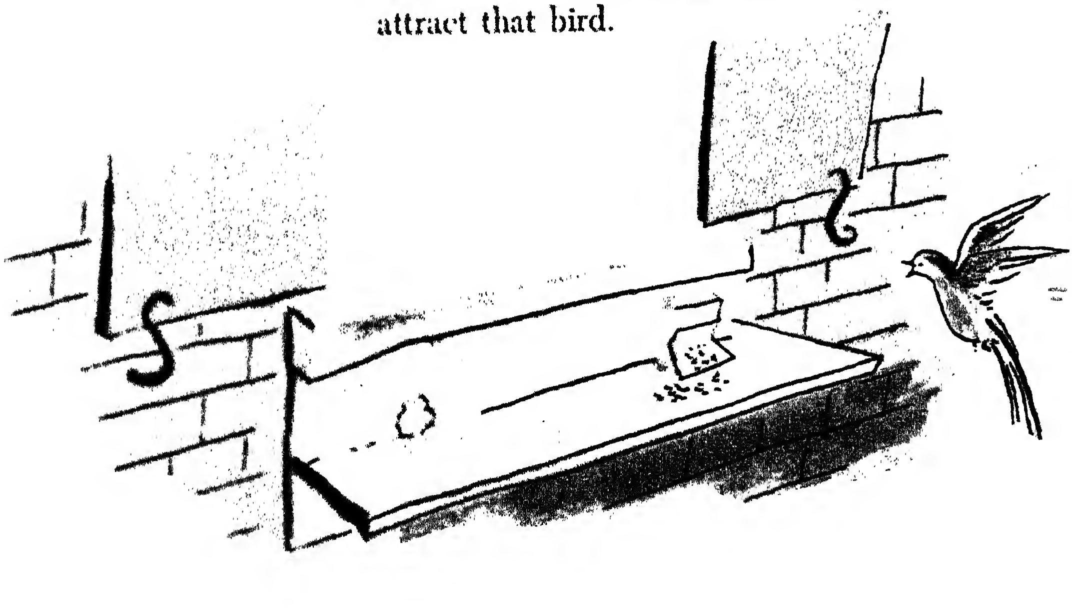
1. What is the best location near your school or home to place a bird-feeding station? Where will it attract most birds? Try putting feeding stations in different locations to find out. Be sure you put the same foods at each station.

2. Plan an experiment to find out if the shape of the feeding station has anything to do with how many birds are attracted.

3. This chart tells the kinds of food that attract different types of birds.

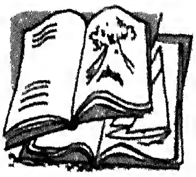
Bird	*Food*
Woodpeckers	Suet, nuts, corn
Chickadees, nuthatches	Suet, nuts, corn, peanuts, sunflower seeds
Mockingbirds, robins, thrashers	Cut apples and oranges, raisins, bread crumbs
Blackbirds, cardinals, towhees	Sunflower seeds, corn, shelled peanuts
Juncoes, finches	Millet, wheat, mixed seeds, bread crumbs

Here is something you can try. Put just one food on the shelf—corn, for example. See which birds come for the one food. Then add another food—say, sunflower seeds. See which birds come now. By this method perhaps you can find out if a certain kind of bird prefers a certain food. Then you can set out the food just to attract that bird.



4. Dig up a piece of sod about six inches deep. Put it into an empty aquarium. Cover the aquarium with a piece of screen or glass, and put it in a warm place. Look at it every day for a week or so. What living things come out of it?

Things to Read About



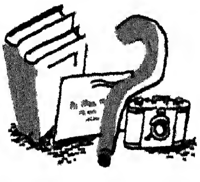
1. Perhaps you have never seen a shrew, since it is most active at night. Look up *shrew* in an encyclopedia to find out how its habits are helpful to man.

2. Make a list of the birds around your community. Have someone report on each bird. Include these things:

a. What different kinds of food should you put out to attract it?

b. What things does it need to build its nest? Does it use things you could put out for it? You might be able to find an old nest it has built. You could use it to show the class how birds use different materials to build the nest.

If You Want to Find Out More



Do birds prefer one color food to another? Use vegetable dye to color some kernels of corn red, others blue, others yellow. Use as many colors as you like.

Put the colored kernels on the feeding shelf. See if the birds prefer one color to another. See if one kind of bird prefers one color while another bird prefers another color.

Try coloring several different foods. Why isn't using corn alone the best way to find out if birds prefer some colors to others?

You can also try out different containers for food. Observe birds carefully while they eat and see if you can "invent" different kinds of containers for the different foods you put out. What can you measure to see which kind is most popular?

Years ago there were large marshes around the town of Stillwater, Nevada. These marshes were good feeding grounds for many kinds of waterfowl. Redheaded ducks, Canada geese, black-crowned night herons, white pelicans, mallard ducks, and many others came there to feed. A plant called alkali bulrush grew in the marshes. This plant supplied food for the birds.

Then dams were built to improve irrigation and to control floods. Sometimes water is dammed up, then released for crops as it is needed. We call this irrigation. These dams changed the paths of several rivers. The marshes still got water, but it came from the run-off water that irrigated the fields. And the water came at a different time of year than before.

Before the dams were built, the marshes were wet during the spring rains. *After* the dams were built, the marshes were dry in the spring. The dams held back most of the spring rain water. During the summer, when the farmers needed water for irrigation, it was released from the dams. The marshes became wet again. But what happened to the wildlife?

This change from spring water to summer water in the marshes made a great difference. Alkali bulrushes are able to live through dry summers, but cattails cannot. When the marshes became wet in the summer, the cattails grew better than the bulrushes. Over the years two-thirds of the marsh became overgrown with cattails.

But cattails are not as good for waterfowl as bulrushes. They do not contain as many valuable nutrients. Besides, the cattails choke the streams and make the water run slower.

Because the plants in the Stillwater marshes changed, the kinds of animals changed, too. Canada geese, mallards, and redheads could not find the food they needed. Many died. Animals less valued by sportsmen moved in.

Canada geese in Michigan

U. S. Fish and Wildlife Service

The Plan to Improve Stillwater

In 1948, the U.S. Fish and Wildlife Service decided to improve the marsh conditions at Stillwater so that waterfowl would return. The U.S. Fish and Wildlife Service, the Nevada Fish and Game Commission, and the local irrigation district worked out a plan. They would keep the marshes wet in the spring and get different plants to grow to attract the waterfowl.

To carry out the plan, the wildlife scientists had to find out exactly what plant foods waterfowl like best and which of these foods have most nutrients. How did they get this information?

They could have observed the ducks eating to find out what plant foods they liked best. What else could they have done?

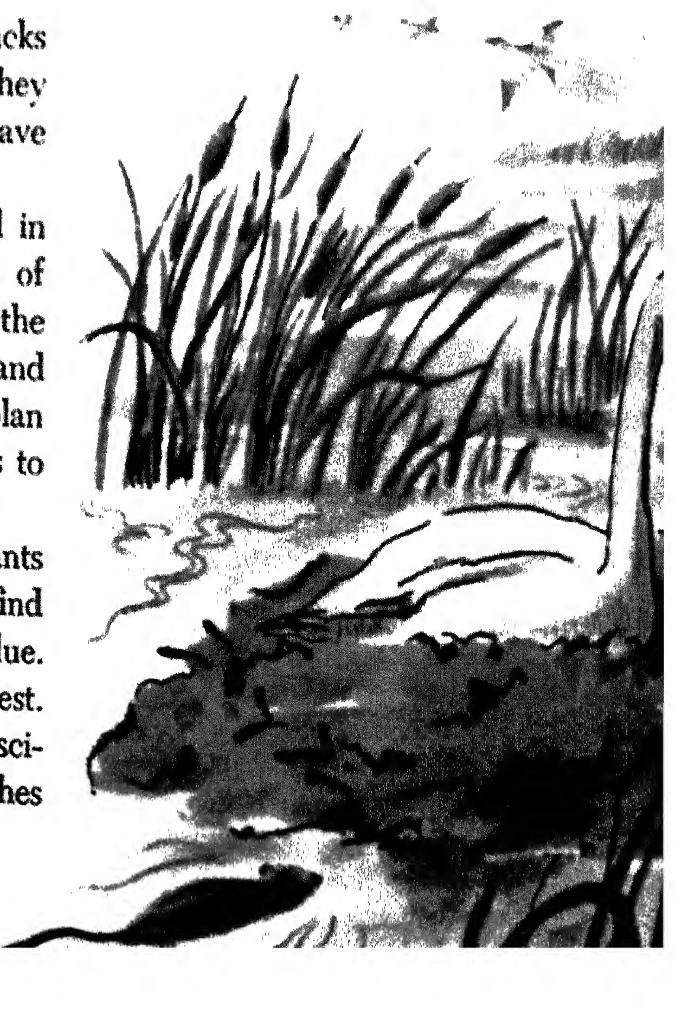
Instead, they examined the food in the stomachs of many hundreds of waterfowl. The food they found in the stomachs told them what the ducks and geese like to eat. Why was this plan better than just watching the birds to discover the foods they liked best?

Once they discovered the plants waterfowl liked best, they had to find out which ones had most food value. Bulrushes and pondweed were best. These were the plants the wildlife scientists decided to grow in the marshes of Stillwater.

Stillwater Today

Let's look at these Nevada marshes today to see the results of careful wildlife management.

In May and June, new marsh plants are growing. It is the breeding season for the waterfowl. Newly hatched Canada geese are swimming through the channels. Teals and redheads are building their nests. Pintails, mallards, and coots are feeding here and there throughout the marshes. Pelicans help keep down the number of carp in the marsh. Carp make the water too muddy for black bass, bullheads, and other fish to lay their eggs. These other kinds of



fish would die out if the carp became too numerous.

By August, there are many animals in the marshes. Ducklings and goslings have grown into ducks and geese. Many waterfowl have flown to Stillwater from other marshes nearby. It is a busy, lively place.

Plants are growing, too. During the summer, the bulrushes and pondweed have become taller. Seeds begin to form on the pondweed. These seeds are the most important food for the ducks during August.

Then, in September and October, mallards, canvasbacks, and other ducks begin to arrive at Stillwater from the North. They stop at Stillwater to feed on their way south.

By the end of October, Stillwater has become quiet. Most of the waterfowl have flown south for the winter. During mild winters a few ducks may stay at Stillwater. They swim on the swifter flowing streams, because these do not freeze over.

But when May comes, the waterfowl start returning, and the Stillwater year begins again.

That is the Stillwater story. It is a story of cooperation between national and state governments. It is a story of what people can do to manage wildlife.

WILDLIFE REFUGES IN NORTH AMERICA

Pribilof Islands
Kodiak
Wood Buffalo Nat. Park
Jasper Nat. Park
Fundy Nat. Park
Parker River
Point Pelee Nat. Park
Upper Mississippi Wildlife and Fish Refuge
Nat. Bison Range
Yellowstone Nat. Park
National Elk Refuge
Hart Mt. Nat. Antelope Refuge

Stillwater
Desert Game Refuge
Chincoteague
Mattamuskeet
Wichita
Cabeza Prieta

Aransas
Wheeler
Okefenokee
St. Marks

Wildlife Refuges

The marsh area at Stillwater, Nevada, is now a wildlife **refuge**. A wildlife refuge is an area set aside for wildlife. There, birds and other animals can find food and raise their young. Generally, hunting is not allowed. The animals are protected so that they will increase in number and spread to surrounding areas.

One of the first wildlife refuges was established in this country in 1870. Since then, the United States government has set aside areas for about 300 refuges. More than 200 of them are for waterfowl. The forty-eight states operate many more. Still others are paid for by groups of people such as the National Audubon Society.

You have read that once there were more than 50 million bison in America. And by 1890 there were no more than 500. But since 1890, the number of bison has increased to about 5,000. How did this happen?

Three areas in the bison country were set aside as bison sanctuaries. A **sanctuary** is a special kind of wildlife refuge. It is generally for one kind of animal only, and no one is allowed to hunt on it. The three bison sanctuaries are the National Bison Range in Montana, the Wichita Refuge in Oklahoma, and Yellowstone National Park in Wyoming.

The prong-horned antelope that used to be so plentiful in the West is now protected also. The Hart Mountain National Antelope Refuge in Oregon, as well as certain refuges in Nevada, are run by the government to protect these beautiful and graceful animals.

The map on page 206 shows where some of these wildlife refuges are located. Which one is nearest to where you live? Perhaps you can visit it.

If you do visit a wildlife refuge, you will probably find plants and animals different from those at Stillwater. Yet any wildlife refuge will be like Stillwater in many ways. There is food for the animals. They can easily find places to raise their young. There is some protection for each animal from its enemies.

A prong-horned antelope

Oregon State Game Commission

Keeping Track of Our Wildlife

Keeping some kinds of animals from disappearing is not the only problem wildlife experts have. They also have the problem of keeping them from becoming too numerous. To help with both of these problems, our wildlife experts keep a population record of different animals. They do this in various ways.

To keep a record of how many people there are in the United States, our government takes a census every ten years. The census takers try to count everyone in the United States. It's a big job. But it's not nearly so big a job as counting all the deer in one state, such as Pennsylvania.

Wildlife management experts cannot count all the wildlife. But they have worked out many different ways of finding out about how many there are in certain parts of the country.

A deer census might be taken by counting deer tracks or places where deer have slept. You can see that this is not a very accurate way. In some states in a certain area the deer are driven past an open place where men count the number of deer that cross a certain line. In some states men fly over deer country in an airplane and count the deer. They count the deer only in certain places. Then they have to estimate what the total number would be for the whole region or the whole state.

Wildlife experts aren't able to tell exactly how many deer, or bear, or foxes there are. But they can tell whether the number of any kind of animal is increasing or decreasing from one year to the next. After all, that is what is important to know.

If an animal census shows that deer are increasing too fast in one state, that state may allow a longer hunting season. Or that state may allow hunters to shoot female deer. If the deer are decreasing in some section, that state may not permit deer hunting there for a while. Wildlife management experts must know what's happening to the wildlife population from year to year. They need this information in order to manage the wildlife properly.

To keep track of animals, wildlife experts must sometimes find out where they travel. Some animals, such as deer, may travel as far as 100 miles in the fall in search of food and shelter. And some fish and birds travel much greater distances.

One kind of salmon lives in the ocean, but it travels hundreds of miles up rivers to lay its eggs. One bird, the arctic tern, holds the record as a traveler. It nests in the far north but flies to the Antarctic to spend the winter. The trip is 11,000 miles and it takes the tern about ten weeks to get there.

One way in which wildlife experts

Dept. of Fish and Game, Sacramento

The band on this pheasant will help wildlife managers keep track of it. The band on the bass will serve the same purpose.

Division of Fish and Game, San Francisco

have learned about the travels of such animals is by marking them. Ducks and other birds are marked by putting a band on one leg. They are trapped alive and let go after the band is put on. The band is made of metal and is numbered. In addition to a number, each metal band has instructions to the person who finds it on the animal. The finder is to return the tag or band to the wildlife experts who put it on. He is to tell them where and when he found the animal. The experts can then tell where it has traveled.

There are a number of reasons why it is important to know where animals travel. Suppose that wildlife management experts find that many ducks are dying on their flight south because the ducks cannot find protected feeding grounds. They then decide to open up several waterfowl refuges for these ducks. They want to be sure that the refuges will be located along the flyways, or regular routes, of these birds. Can you explain how the wildlife managers could find out where the waterfowl flyways are?

Transplanting Wildlife

Before the irrigation dams were built at Stillwater, thousands of muskrats made their homes and raised their young in the wet marshes. When the marshes become dry in the spring, the muskrat population decreased greatly. By 1948, there were hardly any musk-rats left at Stillwater. After the marshes became wet again, 800 muskrats were brought to Stillwater from a wildlife refuge in California. Today there are thousands of muskrats at Stillwater.

Animals are sometimes moved out of crowded places where there is not enough food. Animals are trapped alive in places where there are many of them and taken to places where there are none, or only a few. Deer, bear, wild turkey, beaver, and other wildlife are transplanted this way. The place to which the animals are taken has always been carefully studied to make sure it will be a suitable home for them. The animals are often tagged so that the game managers can keep a record of what happens to them.

New York State Conservation Dept.

Changing the Habits of Wildlife

Elk, like deer, feed in high mountain country in the summer and in the lower country in the winter. The wildlife experts at the National Elk Refuge in Wyoming found that the elk were moving down to the low country too early in the fall. There was still plenty of food available for them in the high country. But there was not enough food in the low country for all of them from early fall to late spring. Many elk were in danger of starving.

The game protectors had a problem. How could the elk be made to stay in the high summer feeding grounds until later in the fall? The game protectors solved this problem by using salt. They knew that elk liked salt. The elk would stay near places where they could get salt. The game protectors dropped 50-pound blocks of it from airplanes at different places in the summer feeding grounds. After that the elk remained in the summer feeding grounds until the snow got so deep they had to move into the low country.

Left: A transplanted beaver is about to be released from a trap. *Below:* Keeping animals from starving in the winter is a problem for wildlife managers. These antelope were trapped on the plains by heavy snows. Wildlife managers tried to herd them to a refuge.

U. S. Fish and Wildlife Service

Fish and Bird Hatcheries

In many parts of our country there are not enough fish for all the people who like to fish. Generally, there are not enough birds, like quail and pheasant, for all who like to hunt them. To increase the number of these animals for hunting and fishing, wildlife experts raise many thousands of them.

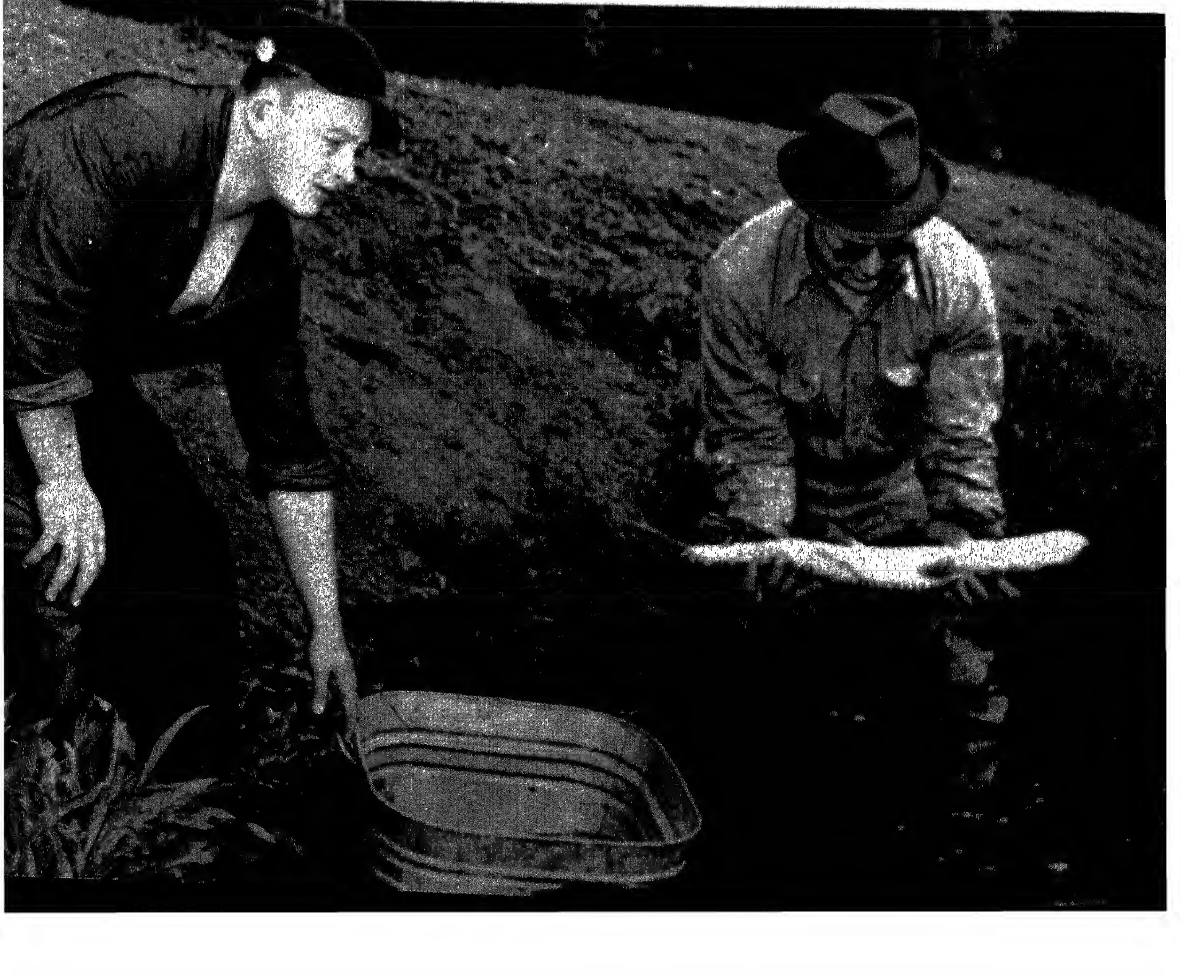
Eggs are taken from live fish and kept in tanks of water to hatch. After the little fish hatch, they are kept in protected ponds. They are fed until they are large enough to be put into streams and lakes.

The population of fish does not increase much by this method. Most of the fish put into streams and lakes are caught during the fishing season.

Birds, such as quail and pheasant, are raised in a similar way. The eggs are collected and hatched in **incubators.** You may have seen an incubator. It is kept at a temperature of about 100° F. At this temperature the eggs hatch in about three weeks. The young birds are fed and protected until they are big enough to look after themselves. Then they are turned out in places where they can find their own food. Sometimes they are put out with older birds. Can you tell why this might be a good idea?

A pike that was raised in a hatchery being released into a stream

Minnesota Department of Conservation



New York State Conservation Dept.

Fire did this.

Preventing Fires

One important way to protect the wildlife is to be careful with fire. Grass fires, brush fires, and forest fires destroy wildlife. In every forest fire, trees and other useful plants are burned. The animals that live there are often destroyed, too. But even if the animals themselves escape, their food and homes are gone.

Almost every forest fire is caused by a person. Sometimes a match is carelessly tossed away. Often campfires are not completely put out. It is up to the people who use the woods to prevent loss of wildlife from forest fires. You can do your share by not being careless with fire whenever you visit a wooded area.

The Natural Enemies of Wildlife

You have seen in this unit how wildlife depends upon other living things. Deer and elk eat buds, young leaves, and fruit from trees and shrubs. Ducks depend upon the seeds of plants for food. The bison live on grass.

Some animals depend upon other animals for their food. One mountain lion, or cougar, will kill as many as 50 deer a year for its food. Coyotes will eat birds, deer, and rabbits. Skunks and opossum will eat birds. Raccoons will catch fish for food. So will some birds such as the heron. Some hawks will kill birds for food. So will some snakes. There are many other examples of animals living on the wildlife that man wants to protect.

Keeping a Balance of Wildlife

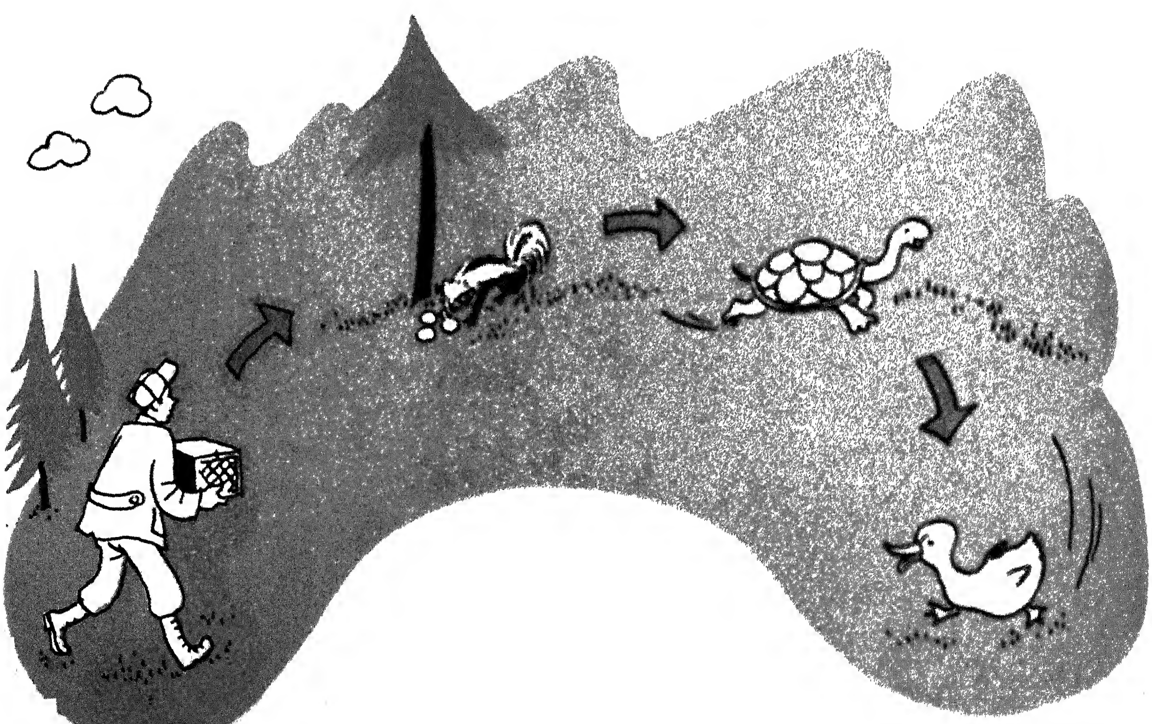
The problem of protecting any bird or animal from its natural enemies would seem to be a simple one to solve. Just kill off their natural enemies. And this might work except for one thing. The animals we would kill eat other animals besides the ones we would like to protect. The other animals might increase till they became worse pests than the ones we had killed off.

Here is what might happen. In a certain marsh in northern New York there had been many waterfowl and other wildlife, including snapping turtles. Skunks fed on the eggs of turtles and the turtle population never got very large. When the price paid for skunk furs became high, many skunks were trapped. The turtle population increased. The turtles ate so many young ducklings that waterfowl soon disappeared from the marsh.

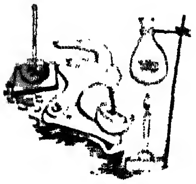
Finally, the price of furs went down. Fewer skunks were trapped. The turtle population decreased. The ducks came back.

The New York marsh is an example of how living things keep a balance. The balance is kept so long as something doesn't disturb it. Wildlife managers are very careful about killing one kind of animal in order to help another kind. They find out all they can about what the animal eats. They find out whether other animals depend upon it for food. They try to make sure that the balance of living things will not be upset.

Wildlife managers know that living things depend upon other living things. When they plan a wildlife refuge they keep this important idea in mind.



Things to Do



1. Visit a park or take a trip around your school grounds to find (a) the places where birds could nest, (b) the places where birds could get water, (c) plants that produce seed which birds could use for food.

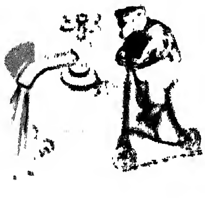
2. The arctic tern takes 10 weeks to fly 11,000 miles from the Arctic to the Antarctic. How many miles a day must it fly? If you walk three miles an hour, how many hours would it take you to make the trip?

3. What animals are hunted in your part of the country? Find out the hunting season for each. Why is it not the same for all animals?

4. To see how some common animals depend on each other, try to make a list of what the following animals need to live. What plants do they depend on? What animals?

rabbit	blue jay	grasshopper
squirrel	garter snake	praying mantis

Things to Talk About



1. Is wildlife management important to someone who doesn't hunt or fish?

2. Why isn't a yard cleaned of brush or a plowed field a good place for birds?

3. Since some hawks kill birds, why shouldn't we kill off all hawks?

4. When is man an enemy of wildlife?

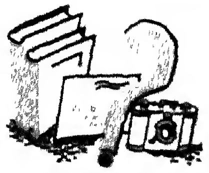
Things to Read About

The U.S. Fish and Wildlife Service has booklets about many of its refuges. Write to the Government Printing Office for booklets on each of these refuges:

Parker River	Wheeler	Mattamusket
Okefenokee	Chincoteague	Aransas

Write for prices first. Ask if there are other booklets.

If You Want to Find Out More



1. Take a census of trees along the sidewalks in your community. Since you may not be able to count all the trees, do it this way. Have each one in your classroom count the number of different kinds of trees along the sidewalk in the block where he lives. Next, figure out about how many blocks like these are in your community. Now can you figure out a way to tell about how many trees there are along the walks in your community?

2. Explore an empty lot or field near your school to find out what food wildlife of different kinds could find there. Look for seeds, insects, worms, and other small animals. If you live near a woods, explore it in the same way. Then compare the woods and the empty lot as a refuge for wildlife.

3. Theodore Roosevelt did much to protect wildlife when he was President. Read what he did in a biography of his life or in an encyclopedia.

9 *Keeping Our Water Safe to Use*

About "*Keeping Our Water Safe to Use*"

If you live where there is little rainfall, you know how important water is. It may have to be brought in by truck from many miles away. It is used only when absolutely necessary.

But even places that have quite a bit of rain don't have enough water at times. New York, Nashville, St. Louis, and Los Angeles, for example, sometimes don't have all the water they need.

In fact, water is becoming harder to get in almost every part of the country. You may wonder why. Rain and snow are the source of all water supplies. And about the same amount of rain and snow will fall this year as last year, or twenty years ago. Each person seems to drink about the same amount of water as he always has. Why, then, should water become harder to get?

You will explore such water-supply problems in this unit. Here are a few more problems you will read about:

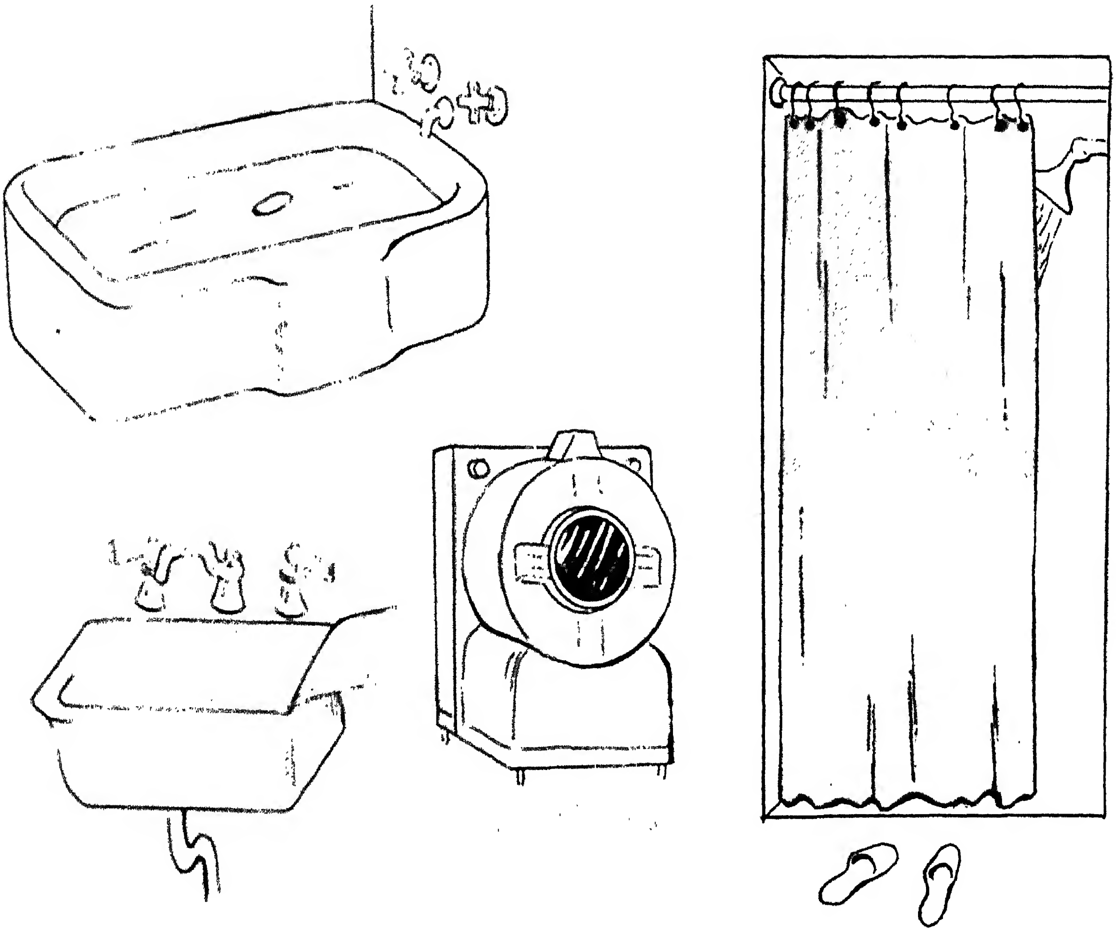
How do towns and cities get water?

How much water do you use?

What is "clean" water?

What can be done to protect your water supply?

How can drinking water be obtained from the sea?



THE MANY USES OF WATER

Not so long ago, southern New England was hard hit by floods. Heavy rains fell for a night and a day, making rivers and creeks overflow. Many homes were destroyed. Some people lost their lives. Whole cities were without electricity, gas, or telephone. Strangely enough, they were also without water! That is, they were without water fit to drink. And they had no running water in their homes.

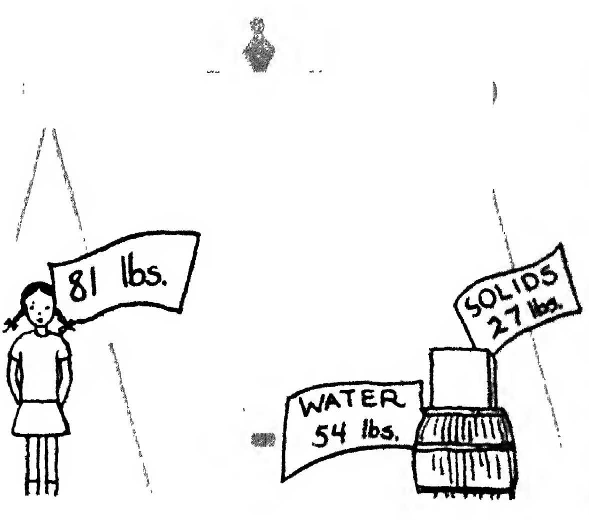
Think of a day without electricity, gas, or running water. What things would you have to do differently? How would your way of living be changed?

But of all the hardships caused by the flood, doing without water was the hardest. People used outdoor fireplaces or wood fires for cooking. They didn't try to keep foods by refrigeration. They got along without TV, radio, and telephones. But water they *had* to have. They needed water for drinking and cooking. They needed water for washing. They needed water to flush the toilets. In ordinary times one person may use as much as 300 quarts of water in a day.

You can name many ways we use water, of course. Can you find out how much water is used each time someone takes a drink from the fountain? Each time you wash the chalkboard? Every time you wash your hands? Try to find out, also, how much water you need to brush your teeth, or clean your paintbrush.

You can see that people in the flooded areas had to do without many things. And you can see why everyone was happy when the water mains were fixed and the water was turned on.

The most important water you use is the water you drink. People have gone without food for several weeks. But no one can live without water for more than a few days.



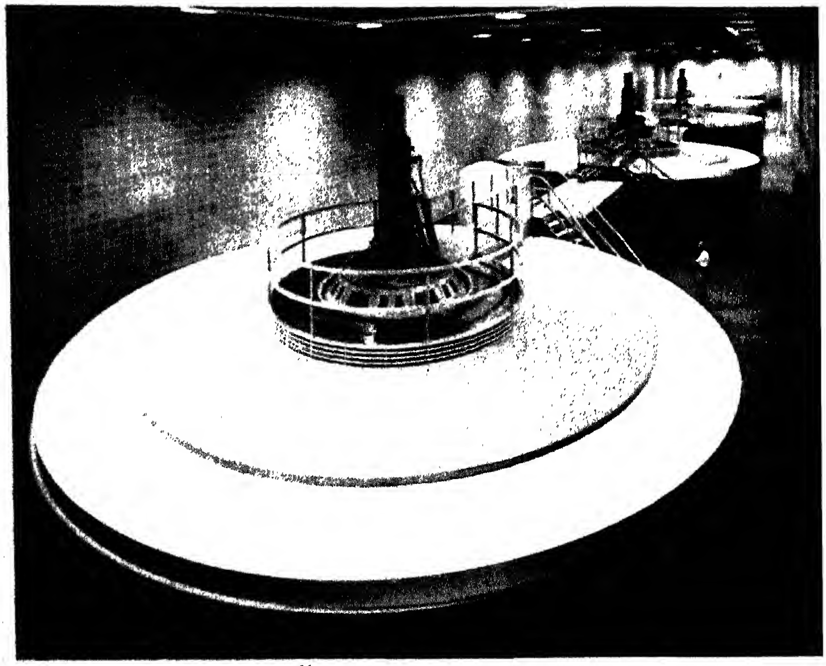
Water in Your Body

Nutrients must dissolve in water before your body can use them. Only when they are dissolved can they pass into your cells. Your blood, which is about nine-tenths water, carries the dissolved nutrients to your cells.

Water also dissolves the waste materials produced in your cells. These waste materials pass through your cell walls and are carried away by the blood. Some of them leave your body in the air you breathe out, some leave in perspiration and in urine.

You can see that the water in your body must be replaced. In a single day you take in about four quarts of water—128 fluid ounces—from food and drink. But in that same day about 41 ounces will leave your body as urine. About 66 ounces will leave as water vapor breathed out from your lungs. About 21 ounces will leave as perspiration. On warm days you perspire more and lose more than 21 ounces of water.

Water makes up about two-thirds of your body weight. Your muscles are about three-quarters water. So are your heart and liver. Your brain is more than four-fifths water. Even the hard parts of your teeth are one-fiftieth water! None of the complicated things that happen in your body to keep you alive could take place without the help of water.



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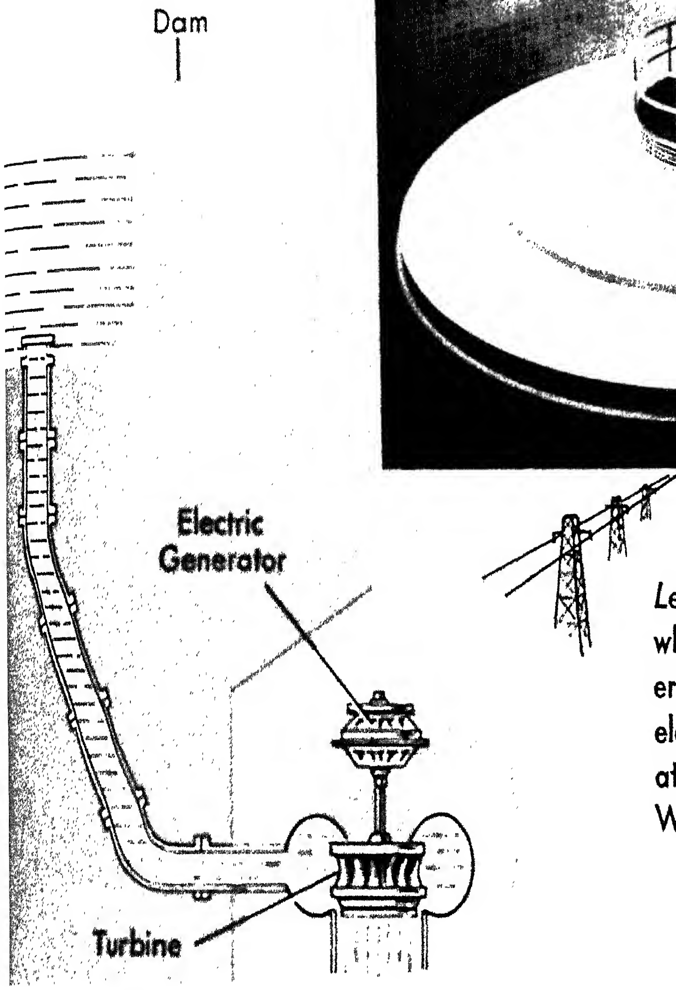


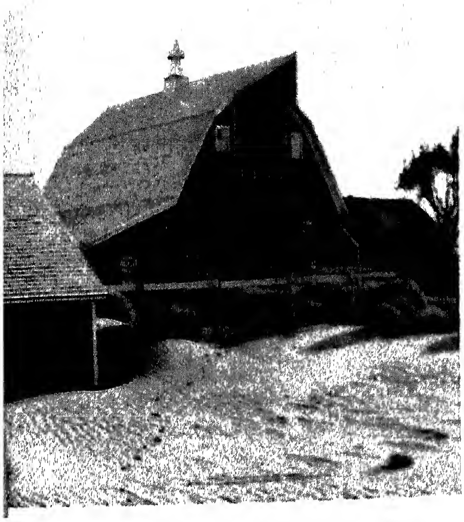
Left: Water turns the turbine which is connected to the generator. The generator produces electricity. *Above:* The generators inside the power plant at Watts Bar Dam in Tennessee

Water in Industry

Not many people realize how much water is needed to make certain products. In dairies and canneries, water is used to clean the food containers. In the steel industry it is used to cool hot metal quickly. About 55 gallons of water are used in making a pound of steel. It took about 15 gallons of water to make the paper in this book.

Water is also used in making electricity. Since water has weight and flows freely, it can be controlled and put to work. Many electric power plants are located at waterfalls or on swiftly flowing rivers. The force of the moving water is used to turn the giant machines that produce electricity. About one-third of the electricity used in the United States is produced this way.

A before-and-after comparison. Water made the difference.



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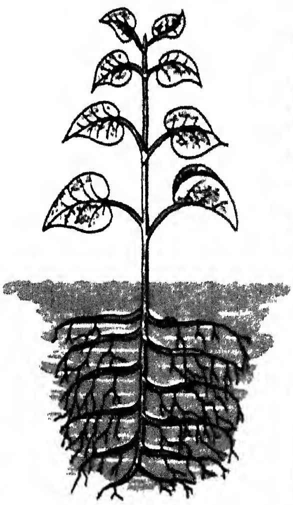
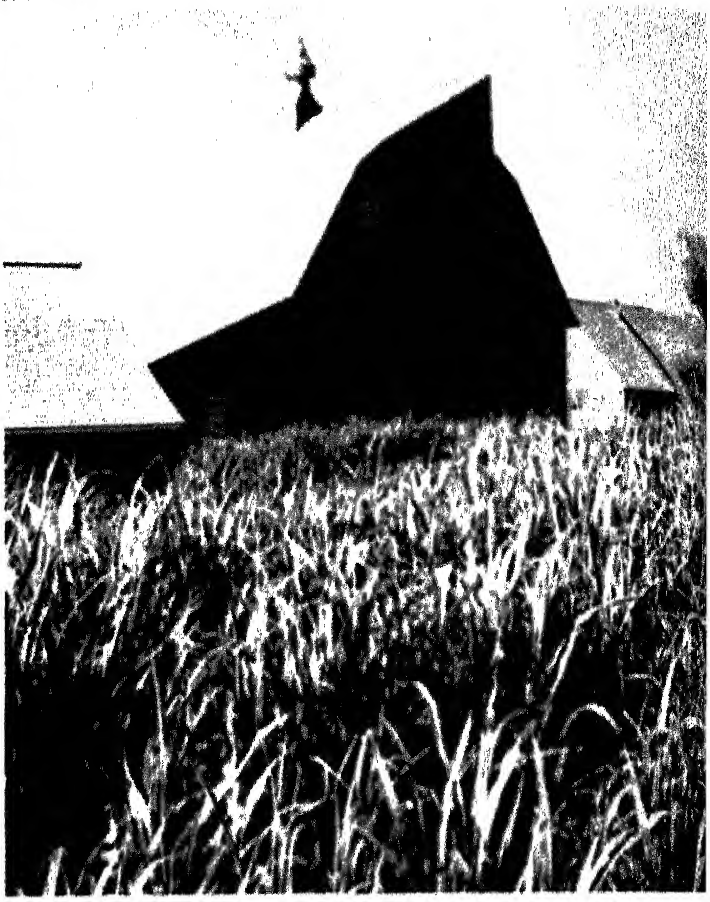




Water for Crops

Crops need water to grow. In areas of little rainfall, water must be brought in for irrigation from places many miles away. One-eighth of all crops grown in this country comes from irrigated land. Deserts in California, Nevada, and Arizona have been changed to farm land by irrigation. Even in sections such as New Jersey and Long Island, N.Y., which have considerable rainfall, irrigation is used from time to time.

Plants need water for much the same reasons as your body does. Water carries mineral nutrients from the soil through the roots to other parts of the plant. It carries manufactured food from the leaves to all other parts of the plant.

Water also keeps the plant from getting too hot. Most of the water that enters the roots evaporates through the leaves. To find out if water is given off through the leaves, put a plastic bag over a plant. Tie the bag tightly around the stem. Notice what forms inside the bag after a day or two.

Have you ever noticed what happens to a flower when you don't water it? Water also helps hold some plants erect.

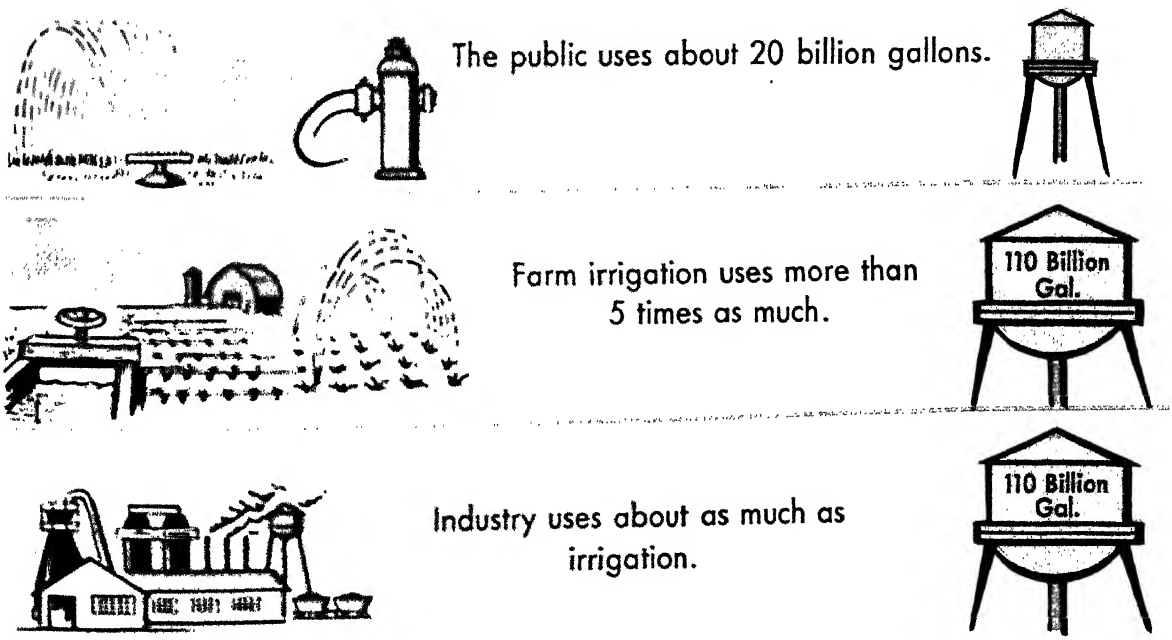
A small amount of water is also used by the plant to make food. Water from the soil and carbon dioxide from the air are used by the green plants to form sugar.

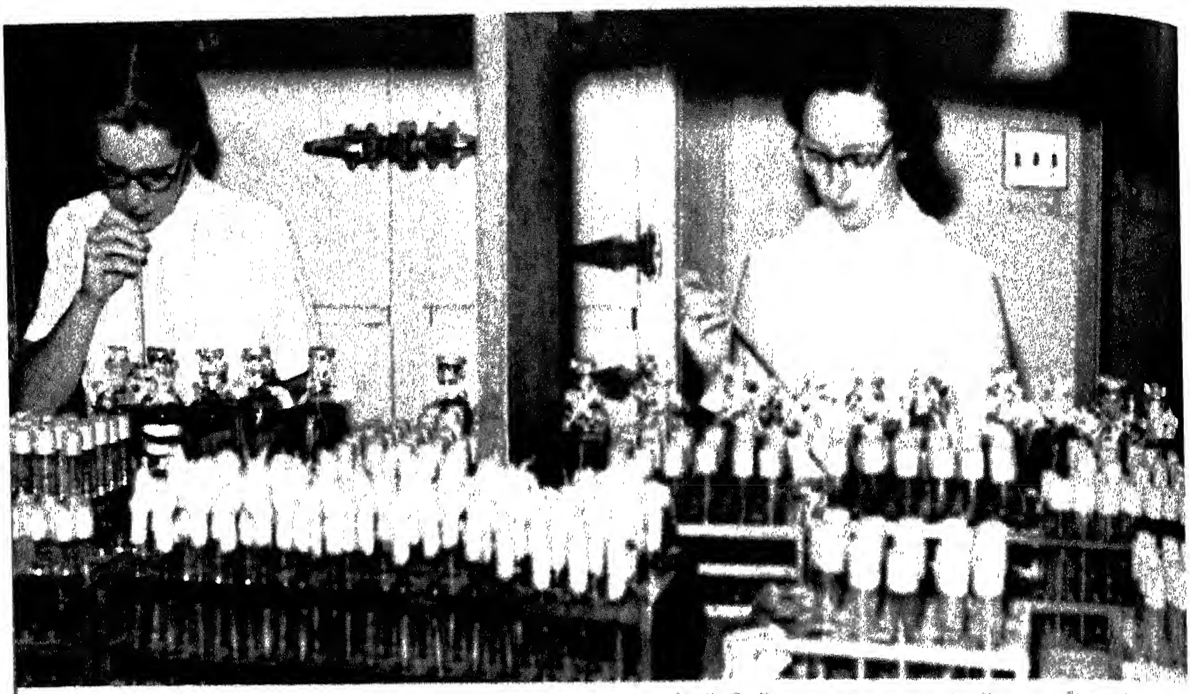
Some Water Problems

More water is used now than ever before. Each person today uses only slightly more water for bathing and washing than each person used in 1900. But today more than twice as many people live in America as in 1900. And we use more water for irrigation and industry.

Many streams and lakes that once supplied water for homes and industry no longer do so. These streams and lakes are still there. But the water in them is not safe to use. We say that it has become polluted.

Water Used Daily in U.S.





N. Y. C. Dept. of Water Supply, Gas, and Electricity

Water samples being tested for purity

What Is Safe Water?

Pure water—water with nothing else in it—is very rare. Even rain water contains certain dissolved chemicals.

There is no simple way to tell if water is safe to drink. Water that is cloudy, tastes bad, or even smells bad may still be safe to drink. To find out whether or not water is safe to drink, special tests must be made.

Most towns test the water often for germs. Even if it looks, tastes, and smells clean, the water may not be safe to drink. It may contain harmful animals and plants which can be seen only with a microscope. Only people with special training can tell whether water is safe to drink.

Some Effects of Pollution

You may know about the harmful effects of unclean water from your own experience. There are many lakes, rivers, and ponds across the country where swimming is not allowed because the water is polluted. The water from these sources cannot be used in homes and other buildings. Your own community may be near such a body of water.

Thousands of towns and cities grew up near rivers and lakes where the people could make use of the water. But today, many of these communities can no longer use the water without expensive treatment to make the water safe.

What Pollution Does to Wildlife

Trout, bass, pike, and many other fish cannot live in polluted water. Neither can ducks, beaver, or muskrat. Even if an animal is able to live in polluted water, it is unsafe to eat the animal. Along parts of the Gulf coast of Mississippi and Louisiana people are not allowed to harvest oysters because the water is polluted. Harvesting oysters is also not allowed off sections of Long Island, New York.

Most pollution happens over a long period of time. But here is an example of what happened to the wildlife when one waterway became polluted suddenly.

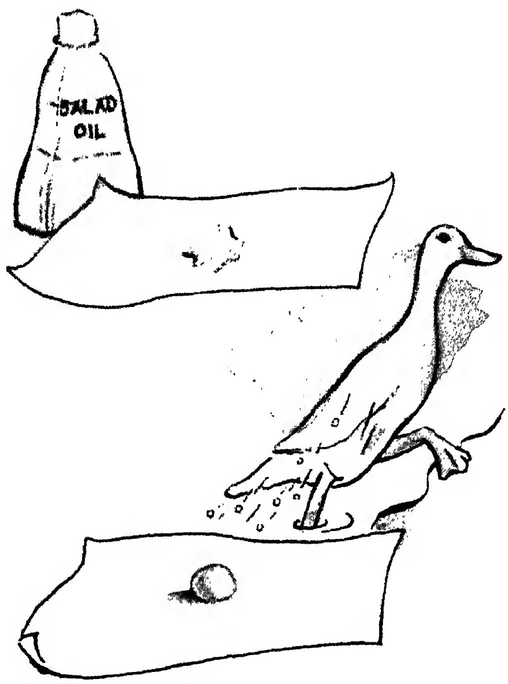
One night a ship was being loaded with oil up the river from a waterfowl refuge in Connecticut. As the machinery silently pumped the oil, the watchman fell asleep. The pumps kept working. Soon the oil overflowed. Gallons of oil poured into the river. Slowly, the oil spread over the water toward the duck refuge.

The next morning thousands of ducks were struggling in the oily water. The oil covered their feathers and made the ducks heavier. Many drowned. Others could not fly because of the added weight of the oil on their wings.

Many valuable waterfowl died that day. It was several years before that part of the river could be used as a waterfowl refuge again.

Why did the oil harm the ducks? If you have ever seen a duck come out of water, you know his feathers are dry. The natural oil on the feathers sheds water. But it doesn't shed oil. Oil clings to oil.

You can see how oil clings to certain substances, while water does not. Get a piece of waxed paper, a medicine dropper, some water, and some oil. With the medicine dropper put a drop of water on the waxed paper. The layer of wax on the paper is like the natural oil on a duck's feathers. The water remains in a ball. It doesn't cling. You can roll the ball off by tilting the paper. Now put a drop of oil on the waxed paper. Try to roll it off. What happens?



Things to Do

1. Do you get a bill for the water you use? If you live in a one-family house, you probably do. Write to the place where you pay your bill, or look at your water bill itself to find out how much you pay for each gallon. Write a letter to the Chamber of Commerce in some other town to compare the cost of water there with yours. Choose a town where the rainfall is either much greater or much less than where you live.

2. Which takes more water, washing dishes in a basin or washing them under running water? Make a plan for finding out.

3. Does your town get electricity from water power? Even if you live a long way from rivers or other bodies of water, you might be using electricity produced by water power. Write to your electric company to find out.

4. How much more water do you drink on a hot day than on a cool day? Make a plan to find out.

Things to Talk About

1. If you had to reduce the amount of water you use each day from 300 quarts to 50 quarts, how would you do it?

2. Should a factory be permitted to pollute the water with wastes if people seldom fish there and no community is using the river for a water supply?

Things to Read About

1. Look up these industries in an encyclopedia to see how they use water: soap making, manufacture of aluminum, oil refining.

2. How much water will one good-sized tree evaporate in a day? Look in an encyclopedia or some library book on trees.

3. How is water used in some air-conditioners?

WHAT CAUSES WATER POLLUTION?

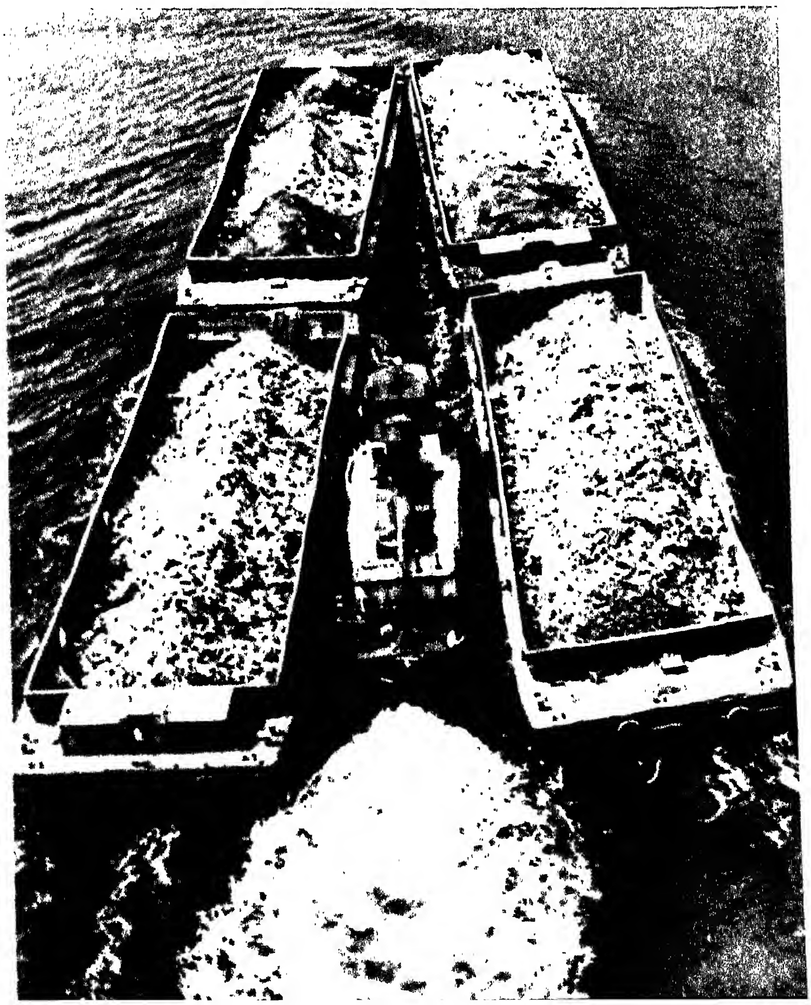
There are three common causes of water pollution. These are pollution by sewage from towns and cities, pollution by factories, and pollution from soil washed into streams.

Pollution From Towns and Cities

You may know that some communities dump sewage and garbage into bodies of water nearby. Sewage contains all the waste materials that go down kitchen drains, bathtub drains, and toilets. Often it carries material washed from city streets as well.

The millions of small plants and animals—mostly bacteria—that normally live in the water eat the sewage. We say that the bacteria **decompose** the sewage. If small amounts of sewage are dumped into the water, the water will not become polluted. Bacteria decompose the sewage before it piles up. But when large amounts of garbage or sewage are dumped into the water in a short time, the water does become polluted. The sewage gathers faster than the bacteria can decompose it. This is what has happened in many lakes and rivers across the country.

N. Y. C. Dept. of Sanitation



Cities and towns must find good ways of getting rid of garbage. New York City transports garbage across the bay and buries it in a special place on Staten Island.

Pollution by Factories

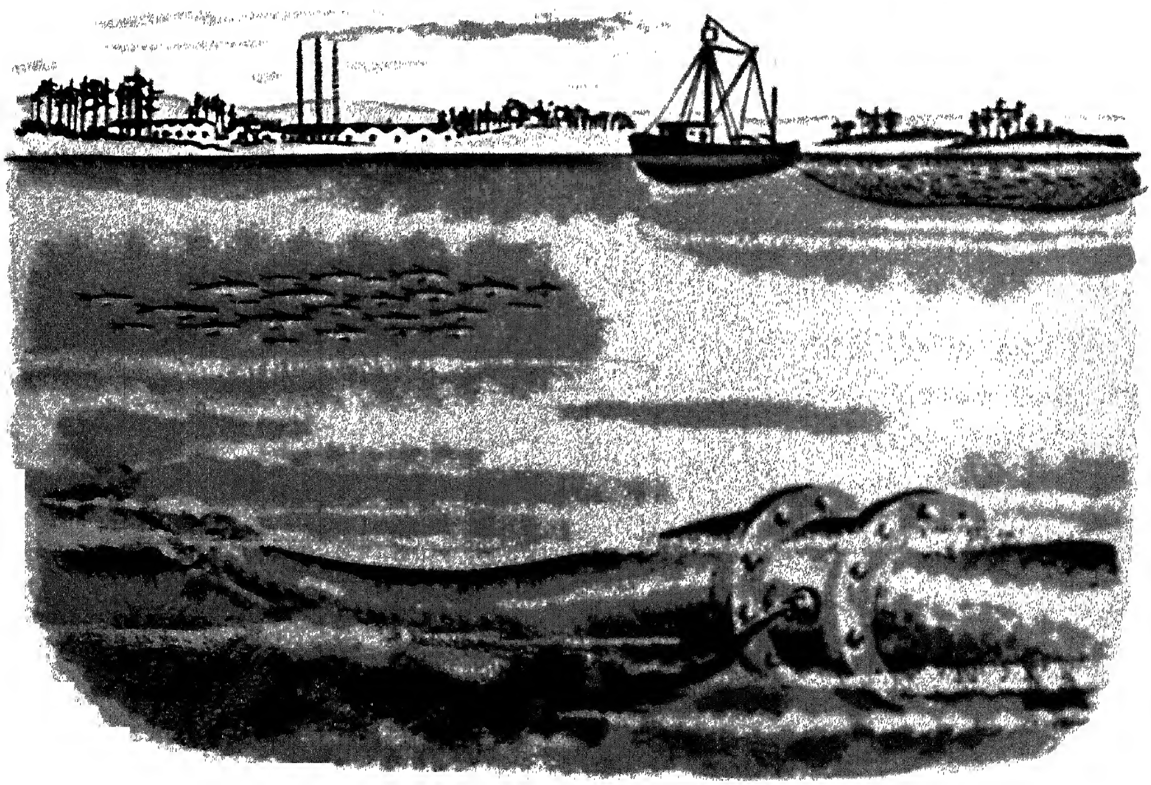
Still another kind of pollution is caused by factories. Some of them release waste materials that make water unsafe for household use and wildlife. Oils, acids, and greases are a few examples of these harmful wastes.

The oil, canning, mining, and paper industries cause pollution in many states. There might even be an example of such pollution in your own town.

Canneries sometimes release waste animal and plant material into the water. Paper mills release waste pulp. Waste materials and sewage are dumped into the water faster than the bacteria can decompose them. The oil industry sometimes causes pollution because certain chemicals in the waste kill the bacteria which decompose the sewage. Mining industries sometimes pollute the water because they release chemicals harmful to people.

More than half the pollution in the country is caused by waste materials from industries. Yet each of these manufacturing industries is necessary. People need oil. They need food. They need paper. They need all the other products of industry—even if the manufacture of these products means the release of harmful wastes. The problem is to control pollution without stopping the industry. Today many factories are finding ways to solve this problem.

A way of solving the problem of factory wastes. They are carried along in a large pipe and let out gradually in amounts too small to pollute the water.



Soil Conservation Service

Soil erosion can make a farm look like this.

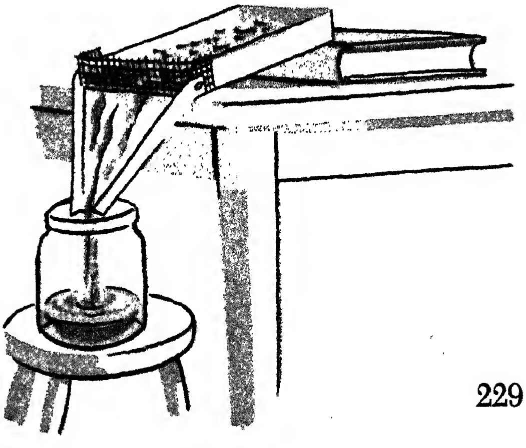
Pollution From Soil Erosion

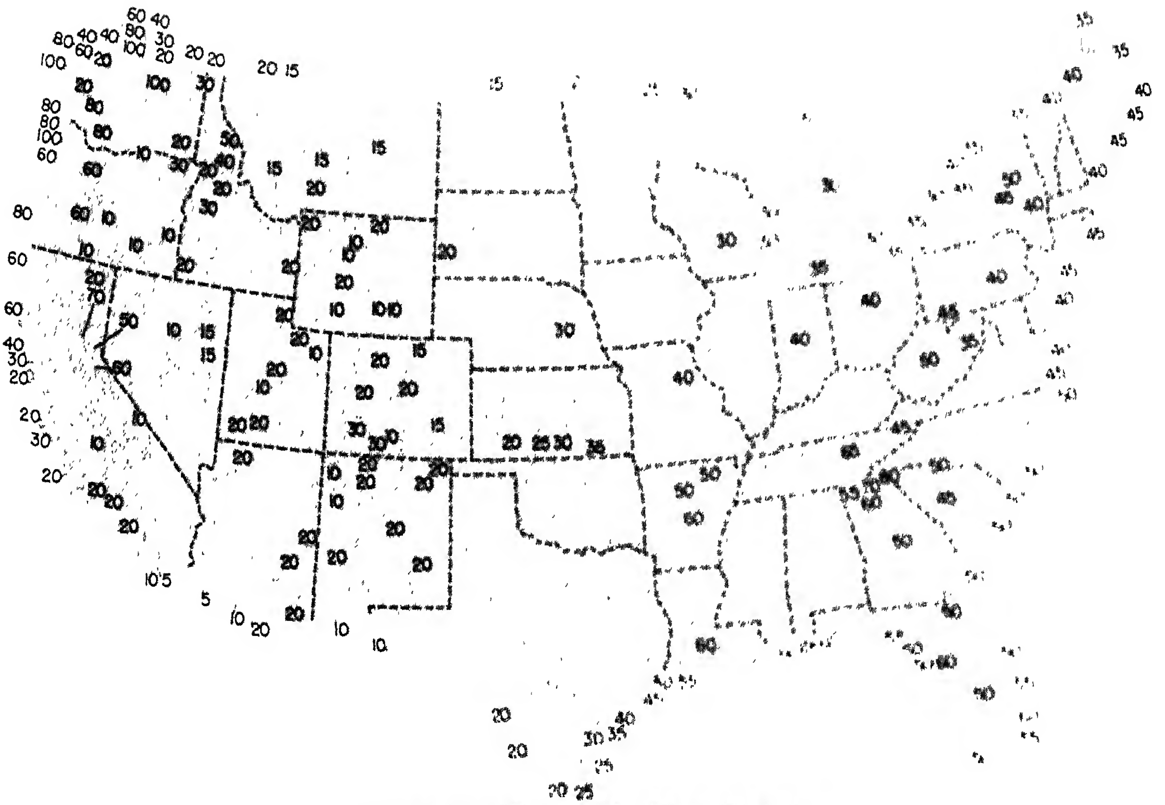
When soil is washed off the land by rain, it travels to streams and rivers. This is one kind of **soil erosion.** The streams and rivers become muddy. Muddy water is useless for home use and for many industrial purposes. Many kinds of fish can't live in muddy water. Why?

Here's something you can try in your classroom to see how water carries away soil. Get a wooden box. Knock out one end and replace it with wire screening. Shape a funnel-type pathway out of aluminum foil and fasten it to the open end of the box as you see in the drawing.

Now fill the box with soil and place it on a slant above a large, wide-mouthed jar. Sprinkle water on the soil. The water will run out through the screening and fall into the jar. How much soil does it carry along with it? What could you do to reduce the erosion?

Is soil erosion a problem in your community? Is there a hillside near your school where soil is washed down during every heavy rain? Perhaps you can visit such a hillside after a rain and collect bottles of run-off water to see how much soil it is carrying.





SOURCES OF WATER

• The water supply in every community depends on rain and snow. From the rainfall map on this page, you can tell how many inches of water to expect in your own area this year.

The number of inches shown on rainfall maps include both rain and snow. But you know that an inch of snow is not equal to an inch of rain. It takes about ten inches of snow to give as much water as one inch of rain. If a community had twenty inches of rain and forty inches of snow, twenty-four inches are recorded on the map.

To read the map, look for the curved line nearest your town. Follow this line to the edge of the map. There you will find a number. The number tells the average number of inches of water that have fallen over your area in a year for the past several years. You may get more—or less—in any one year. The average is recorded on the map.

How does the rainfall in your community compare with the rainfall in other sections of the country?

The Water Cycle

As you probably know, the water that comes out of a rain cloud gets into the air from many places. You know that when wet clothes are hung out to dry, the water on them disappears. You know that a wet pavement dries up after a storm.

When water evaporates, it changes to water vapor. The water is no longer a liquid but a gas. Like any invisible gas, water vapor is dry and colorless.

Try to imagine a box one mile high, one mile wide, and one mile long. That's a cubic mile. About 80,000 cubic miles of water evaporate from the ocean each year. About 15,000 cubic miles of water evaporate from land surfaces each year.

Living things give off water vapor into the air, also. Water vapor goes into the air from the leaves of plants. You breathe out water vapor every time you exhale. Animals exhale water vapor, too. This water vapor mixes with all the other gases in the air.

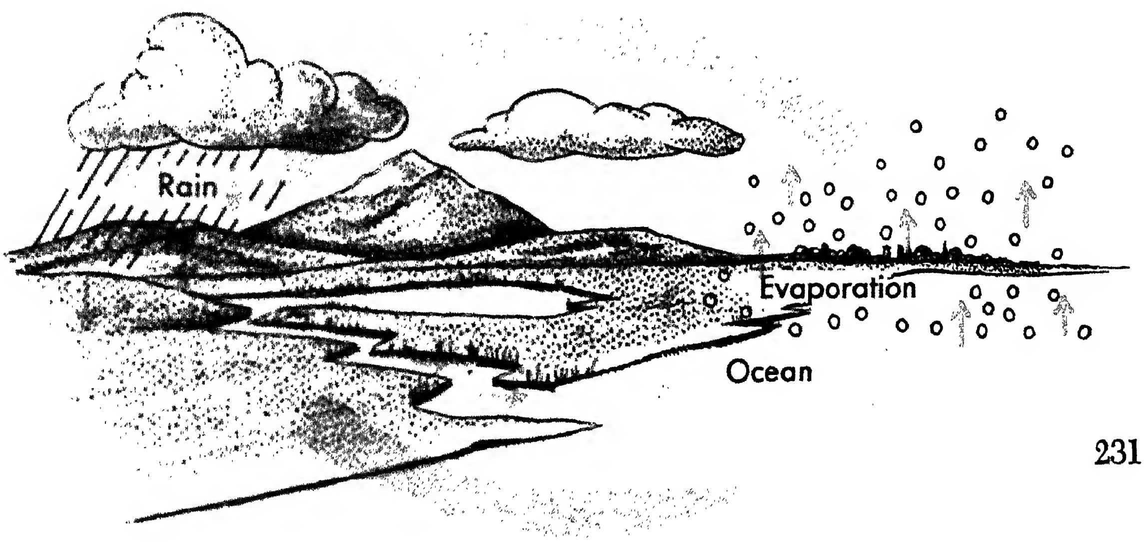
The amount of water vapor in the air changes from day to day and from area to area. How can you tell when there is more water vapor in the air on a hot day? How can you tell on a cold day?

Hail, snow, rain, and sleet are four different ways in which water is returned to the earth out of the air. Frost and dew are two more ways. Can you guess what causes dew or frost? What cools the water vapor to form dew?

The constant changing of water from liquid to vapor and then back to liquid again is called the **water cycle.** A cycle is something that repeats itself many times.

The drawing on this page shows some of the steps in the cycle. You see the areas from which much of the water evaporates. You see that clouds form when water vapor in the air condenses to liquid. Then you see that water returns to earth from clouds. On earth, water collects in streams, lakes, and oceans. Some of it first soaks underground and then flows to oceans and lakes.

The two forces that furnish the energy for this life-giving cycle are the sun and gravity. The sun warms the water, giving energy for evaporation. Gravity pulls the water droplets back to earth.



Natural Storage of Water

Rain or snow cannot be used as fast as it falls. During one rainstorm, thousands of gallons of water may fall. Enough rain may fall to provide a large city with all the water it needs for several days. It must be stored where it can be used as needed. Some of it soaks into the earth. Some of it collects in ponds and lakes. Some of it flows off in streams and rivers and finally to the ocean.

If rain or snow falls onto a steep hillside, much of it will run off into streams and rivers. If it falls on flat land, more of it will soak into the soil. Some of it may be used by plants. The rest may sink more deeply into the rocky material of the earth.

Most crops get their water from near the surface of the soil. Most of their roots do not go much deeper than three or four feet. Water that soaks more deeply may be lost to them. Some of it, however, will move up through the tiny spaces between particles of soil. You can see how this happens. Fill a tall glass, like an olive jar, with dry soil. Carefully turn it upside down in a pan of water. How far up does the soil become wet?

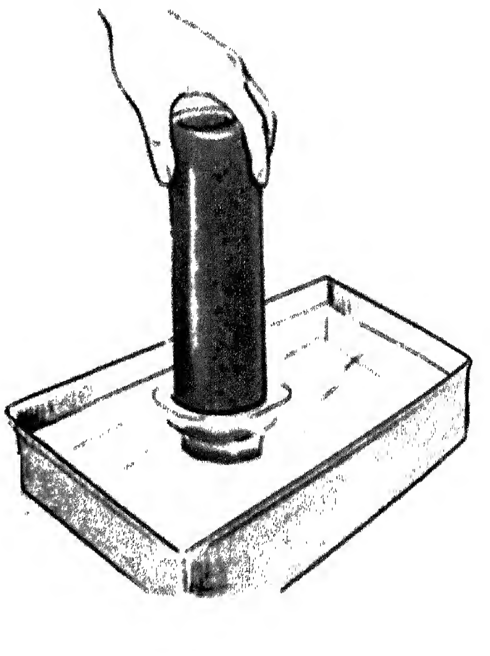
Not all the water that soaks deep into the ground or flows off hillsides is lost. On the next few pages, you will discover how this water can be used.

Surface Water

By surface water we mean lakes and rivers. Surface water is used most easily by man. No drilling is necessary to get the water. Communities like Chicago, which are near a large body of clean water, can get water easily.

Some big rivers are always a good source of water. But some rivers may have a great deal of water at certain times and very little at other times. In rivers like this, water may be held back, or stored, by building dams.

Where the land is bare, water runs off very rapidly, causing erosion. But where the land is covered with trees or grass, water runs off more slowly. Forests slow down the flow of rain water in several ways. The trees shade the snow and keep it from melting fast. The soil in a forest soaks up water almost like a sponge.



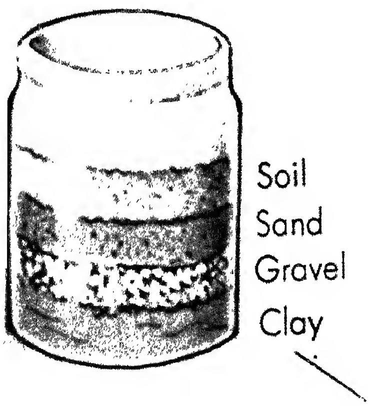
Snow melts slowly in the forest.

U. S. Fish and Wildlife Service

Ground Water

Whenever it rains, water soaks into the soil. If there is enough rain, water continues to soak into the ground until it is stopped by a layer of rock. This solid layer of rock will not let the water go deeper. Sometimes this layer of rock is a few feet below the surface of the earth. Sometimes it is hundreds of feet below.

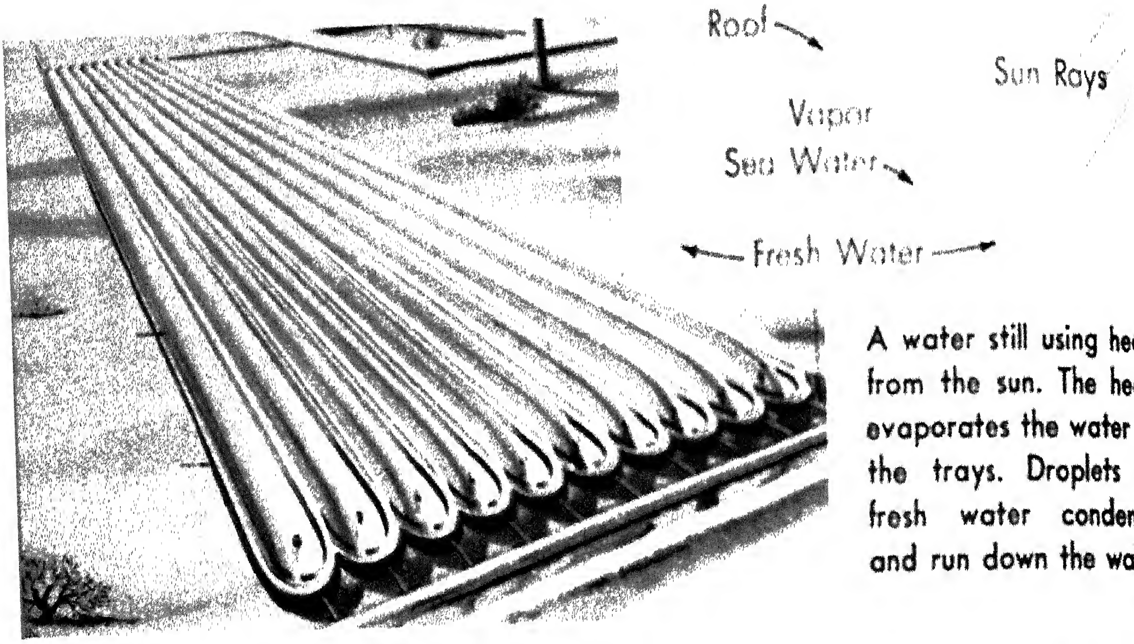
When the water strikes this layer of rock, it begins to form a sort of "pool." This "pool" is called ground water. Ground water fills up all the spaces between small particles of rock.



To see how this happens, you can make a model showing the layers the water soaks through. You will need a wide-mouthed jar, modeling clay, gravel, soil, and sand. First put a layer of clay in the jar. Make sure it is pressed against the sides of the jar. Now put in a layer of gravel. Next, the sand, and, finally the soil.

Pour in a little water. The clay represents the layer of rock that doesn't permit water to seep through. The ground water settles above the clay in spaces between particles of gravel and sand.

Ground water forms underground streams in some places. Perhaps you have seen one at the bottom of a huge cave. But even the ground water between rock particles is moving. The water slowly flows down the slope of the underground layers of rock. Even ground water finally moves into a lake, pond, river, or ocean.



A water still using heat from the sun. The heat evaporates the water in the trays. Droplets of fresh water condense and run down the walls.

Water From the Sea

Three-quarters of the earth's surface is covered by oceans. But ocean water cannot be used for many household or industrial purposes. If a person swallows too much salt water, it will make him very sick. Everyone must have fresh water for good health.

Salt water can be changed to fresh water. You can show how this is done by dissolving some salt in a quarter of a jar of water. Put in enough salt to make the water taste very salty. Don't let the salt water touch the sides of the upper half of the jar. Now cover the jar tightly.

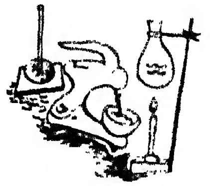
After a few hours what do you see on the sides of the jar? Where did they come from? Taste some of them. Are they salty?

Now uncover the jar and let it stand for several days until all the water evaporates. What is left at the bottom of the jar?

Many ships cannot carry all the fresh water needed for a long voyage. These ships carry **stills**. The picture shows you how a still works. In some stills the heat from the sun evaporates the water. Some stills need fuel. Most stills have a part that cools the water vapor to change it to a liquid. The fresh water produced by this method is called distilled water. Distilled water is pure water. It has no chemicals dissolved in it.

Distilling sea water is an expensive way to get drinking water. But on ships it is cheaper than carrying along all the fresh water needed. Cheaper ways of distilling sea water may be found. If this happens, some communities may get their water supply from the ocean.

Things to Do



1. Find out where your water comes from. Write to the water company or the water supply department of your city government to find out.

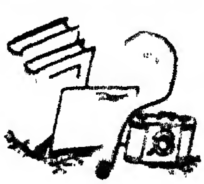
2. Write to the U.S. Geological Survey, Washington 25, D.C., for maps of the area in which your community is located. Find the hills, valleys, streams, ponds, and lakes around your community. See if you can tell from which direction the streams flow.

3. By using crushed ice cubes as snow, an electric light as the sun, and pieces of paper as trees do an experiment to show that snow in a forest will melt more slowly than snow in the open.

4. Explain why you can see your breath on a cold day.

5. Make some hailstones in the following way. Freeze a thin layer of water in the bottom of an ice tray. After the first layer is frozen, add another thin layer of water. Keep this up until you have a full tray of frozen ice cubes. Now remove the cubes and examine them to see if you can find each layer of ice. Although hailstones are round, their layers look like the ones you have made. Can you explain now how hailstones are formed?

If You Want to Find Out More



1. Build a model to show the water cycle. Use a cardboard box. What materials can you use to show bodies of water? What can you use to show clouds? What can you use to show rainfall? Label each part of the cycle.

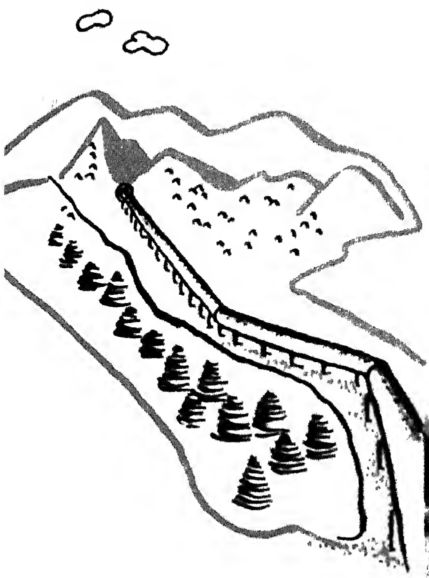
2. Make a diagram to show how a water still that burns fuel might work. Can you invent a still that will work, using the power of the sun? Make a diagram of your invention.

Many cities use water from nearby lakes and rivers. If the water is not badly polluted, the cost of making it safe to drink is not too great. But when the water is badly polluted, the cost is so great that water must come from other sources.

Dams may be built to hold back some of the water in rivers where it is usable. Dams may also be built to collect the run-off water from many little streams. A sort of lake forms behind the dam. This lake is called a **reservoir.** The dam holds water in the reservoir until it is needed in the city. Such reservoirs are often hundreds of miles away from the city where the water is used.

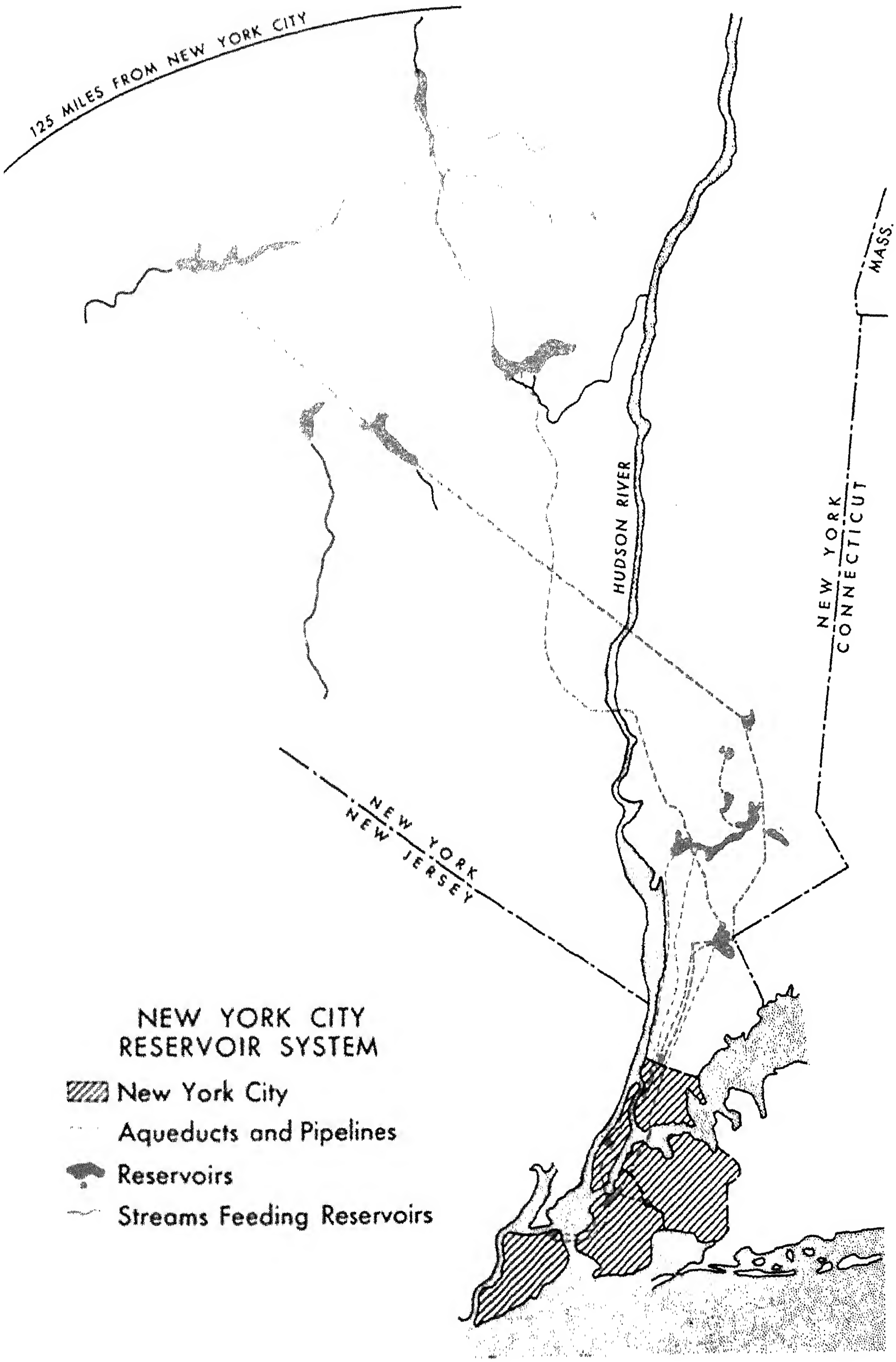
Look at the map of the New York City reservoir system. Notice that New York City needs several reservoirs to provide water for its millions of people. Each reservoir is built in a spot where it collects run-off water from miles around. The area from which a river, lake, or reservoir collects the run-off water is called its **watershed.** Can you tell why forests make good watersheds?

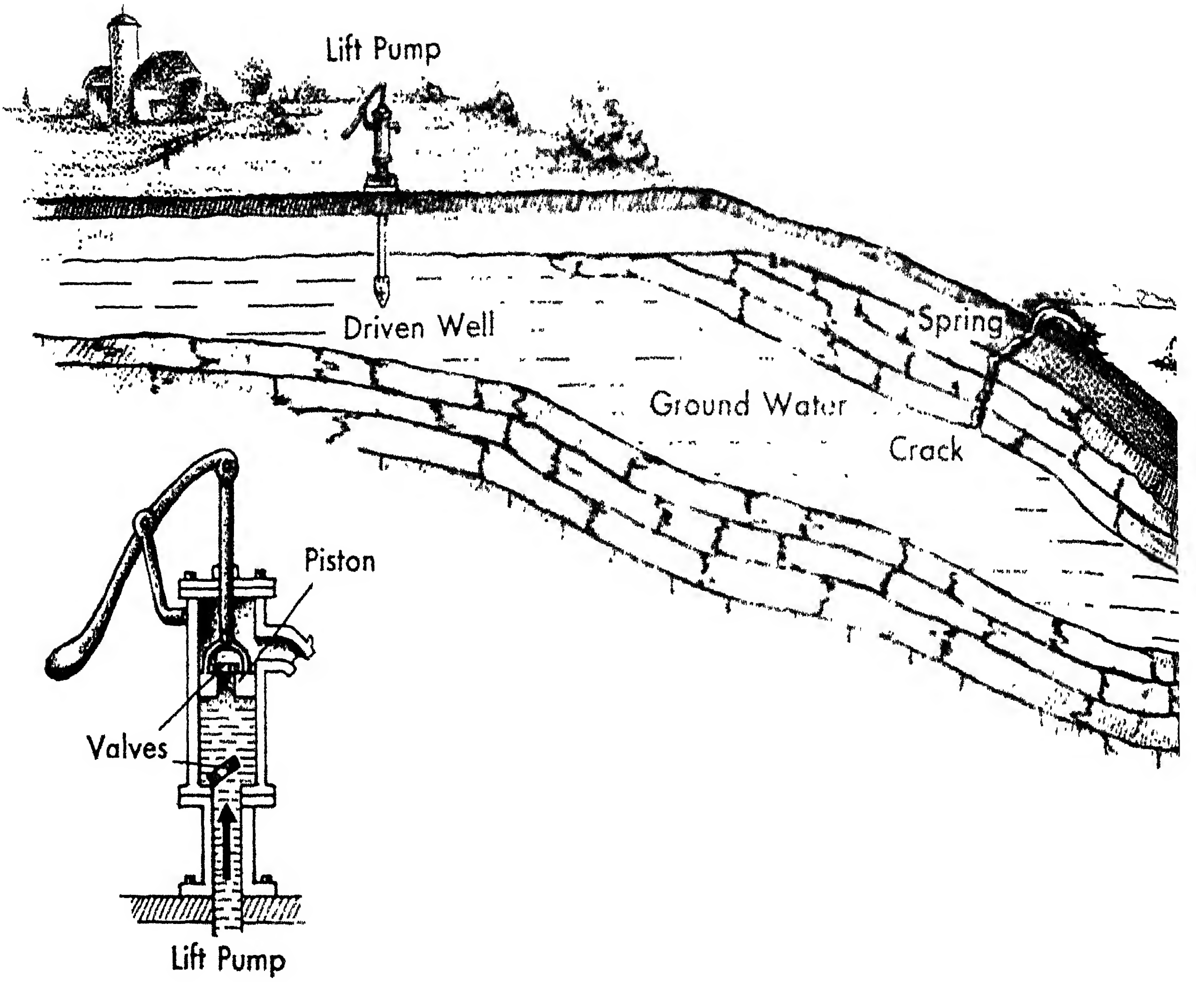
Wherever possible, reservoirs are built on higher land than the cities they supply. The water can then run downhill by the force of gravity. Pumps are not needed to force the water along. How does this help to explain why they are sometimes located a long way from the city?



This reservoir is part of the water system of Los Angeles.

Los Angeles Bureau of Water Works and Supply


125 MILES FROM NEW YORK CITY
HUDSON RIVER
MASS.
NEW YORK
CONNECTICUT
NEW YORK
NEW JERSEY
NEW YORK CITY
RESERVOIR SYSTEM
New York City
Aqueducts and Pipelines
Reservoirs
Streams Feeding Reservoirs



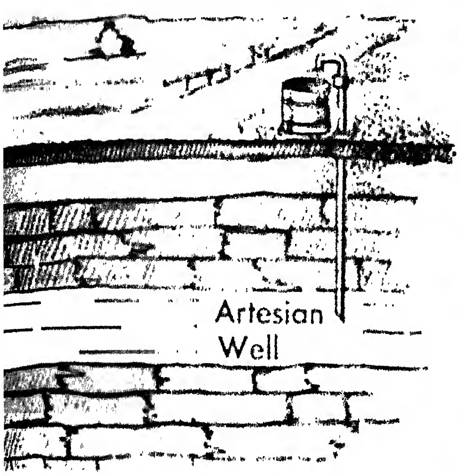
Using Ground Water

Many communities and individual farm homes use ground water from springs. There may be no lakes or rivers nearby. Or they may be polluted and it would cost too much to make the water safe to drink.

Any place where ground water comes out of the ground is called a spring. You have seen the level of a lake or stream rise when there has been a heavy rain. The level of the ground water rises, too, when there has been a heavy rain. We call the level of the ground water the **water table.** Ground water can come up when the table is higher than the level of the ground.

In one type of spring, the ground water is trapped between two layers of rock. The water moves underground until it comes to a crack in the upper layer of rock. It may rise through this crack to the surface of the ground.

If there is no crack in the upper layer of rock, a well can be drilled through it. The ground water flows up with little or no pumping because of the pressure of the water above. Such a well is called an **artesian well.**



A newly-drilled artesian well

C. W. Lauman Co.

Another kind of well is driven into ground water. But the water does not flow out of the ground as it does from a spring. It has to be pumped up. In different sections of the country, wells must be drilled to different depths to get water. If the water table is high, it will not be necessary to drill very far down.

Perhaps your community has a tank to store water. Usually water storage tanks are located on hilltops or tall buildings. Water is pumped up to them. It then flows from them to faucets by the force of gravity.

The height of the water table depends upon several things. During periods of little or no rainfall, it naturally becomes lower. When there is a good deal of rain, it is higher. It may drop sharply when water is pumped out faster than the ground water can be replaced by rain or melting snow. Can you explain why shallow wells may run dry before deeper wells run dry?

What will happen if communities that depend upon ground water pump water out faster than it can be replaced?

Chemicals in Water

You know that water dissolves many substances. So it should not surprise you to read that every time you take a drink, you are swallowing other things besides water.

Are there any chemicals dissolved in your drinking water? Try this. Fill a pie pan with water and let it stand in a warm place.

When all the water has evaporated, look carefully at the bottom of the pan. What do you see?

Rain water is the purest kind of water you can get easily. Yet even rain water may contain dissolved gases and particles of dust. However, if you catch rain water in a clean glass and drink it, you are drinking almost pure water.

After rain falls, it soaks through layers of rocks and soil. As it passes through these rocks, it dissolves tiny amounts of minerals from the rocks and soil. Usually these minerals in drinking water are harmless. They do not make the water unsafe to drink. In some places, the water contains many minerals. Some people go to such places to take mineral baths because they consider "mineral water" healthful. The "mineral water" in some places is bottled and sold. But there is no proof that such water has cured any diseases.

Hard Water

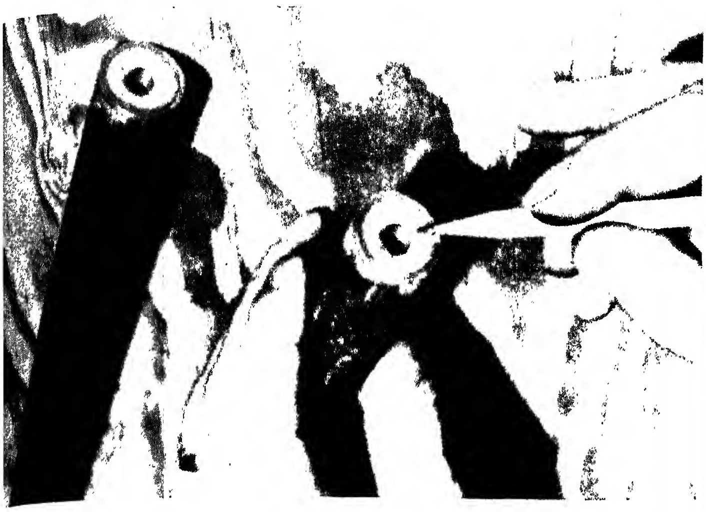
Perhaps you live in a community where soap does not lather easily in the water. This type of water is called hard water. You cannot recognize such water by looking at it or feeling it.

Hard water is caused by certain chemicals which dissolve in the water as the water soaks into the ground. When things mix with water and do not separate, we say they dissolve.

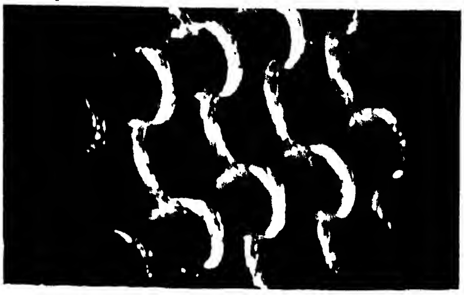
Although many things will dissolve in water, some will not. You can test this statement by comparing sugar, starch, salt, oil, pepper, chalk dust, baking soda, and others when you mix them with water. Before you mix them, have the class list those they think will dissolve and those that will not. How could you prove that the water contained the dissolved materials even though you could not see them?

Hard water can be softened by removing the chemicals that make it hard. One method is to use soap. After soap removes some of the chemicals from the water, a lather begins to form. But this method is expensive. It uses up lots of soap.

If you have hard water in your town, you can see for yourself how soap removes the hardness. Wash your hands in a bowl of hard water. Before you get any lather, you will notice that a scum forms. This scum was made

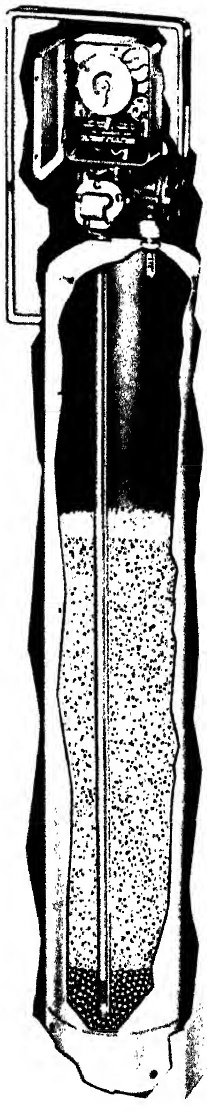


Nylon washed in hard water



Nylon washed in soft water

Above: Some of the minerals in hard water remain in the pipes. As time goes on, the openings in the pipes get narrower and narrower. *Right:* When hard water is run through a tank like this, the chemicals in the tank absorb the hardness minerals.



Photos, Culligan Soft Water Institute

when some of the soap combined with the chemicals that make the water hard. The scum will not dissolve. After the scum has formed, the soap lathers up. The chemicals have been removed from the water by the soap you used up at first.

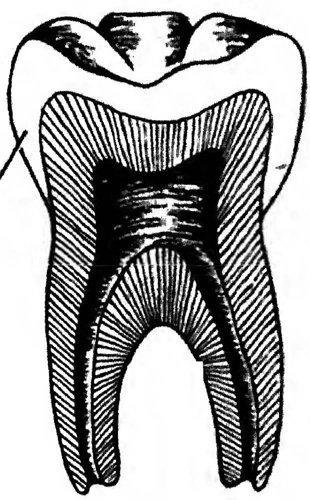
There are better ways of softening water than by using soap. The hard water is passed through special materials. These materials remove the minerals that make the water hard.

In some homes, all water that is used is passed through a tank with these special chemicals. In a few communities, the entire water supply is softened in this manner.

Fluoride

Why do some children have more tooth decay than others? One reason is diet. Dentists believe that too much sugar, for example, seems to increase tooth decay. Also, some people seem to be born with less ability to resist decay. But in recent years, scientists have discovered a way to treat drinking water to reduce tooth decay. Like many important discoveries, this discovery was accidental. It was made when the scientists were trying to find out something else.

Dentists had long known that some people have yellow spots on their teeth. But they never knew what caused the spots. In 1908, a dentist in Colorado Springs noticed that all the people with spotted, or "mottled," teeth in his community had lived there since they were very young. Yet in a community only four miles away, the people did not have mottled teeth. Why?



The dentist, Dr. Frederick McKay, found that the people in both communities ate about the same foods. They did about the same kinds of work. Both communities had similar weather.

But the two communities got their drinking water from different sources.

Then it was found that in other parts of the United States people had mottled teeth. Yet people in nearby communities did not. In every case it was found that water came from different sources.

A study was made of these communities where people had mottled teeth. In 1931, the cause of the mottling was discovered. In each of the communities where people had mottled teeth, the water contained a small amount of a chemical called **fluoride**. This fluoride had been carried into the water supply from the soil. In all the other communities the water contained no fluoride or very little of it.

Some scientists did an experiment to find out if fluoride really caused mottling. They changed the water supply in two communities where there had been mottling—Oakley, Idaho, and Bauxite, Arkansas. These two communities then had less fluoride in their water supply. After eight years, there seemed to be no new mottling among the young children. It seemed certain that fluoride was the cause.

Then several dentists noticed that people who had lots of fluoride in the water also had very little tooth decay. Comparisons were made in several communities. Each comparison indicated that fluoride reduced tooth decay.

Public health scientists then did several experiments to find out how effective and how safe the fluoride was. Here's a description of one such experiment.

The Grand Rapids-Muskegon Study

Two communities in Michigan, Grand Rapids and Muskegon, were selected for study. Both cities obtained their water from Lake Michigan.

Neither community had fluoride in its water. Dentists examined the children who had lived almost all their lives in each city. Why was this necessary?

There were 19,680 children in Grand Rapids and 4,291 in Muskegon. For the study, 5,116 children were also examined in Aurora, Illinois. The water supply used by Aurora for many years contained fluoride. Why do you think the public health scientists selected Aurora for study as well as the two cities in Michigan?

Fluoride was then added to the Grand Rapids water supply, but only enough fluoride to reduce decay, yet not cause mottling.

After six and one-half years, it was found that tooth decay was reduced sharply in Grand Rapids—by about two-thirds among the six-year-olds to about a fifth among sixteen-year-olds. Muskegon children had the same rate of decay as before. It was also noticed that the rate of tooth decay in Grand Rapids was now about the same as in Aurora.

Similar comparisons were carried out in Newburgh and Kingston, New York, and in Brantford, Ontario. Each experiment showed results similar to the Grand Rapids-Muskegon comparison.

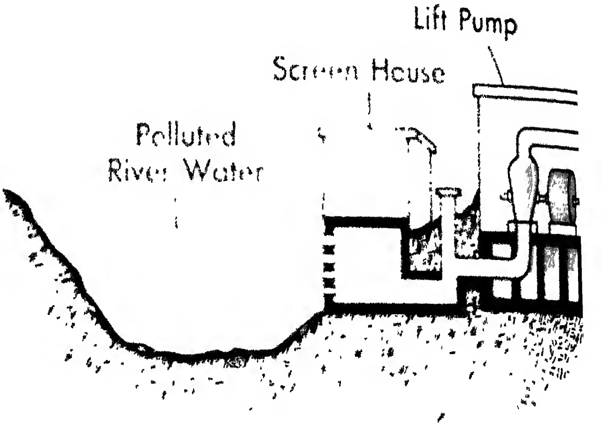
Making a scientific discovery is only the first part of a problem. The next step is to get people to accept the new facts. All people want evidence before acting on something new. But some people want more evidence than others. In some communities, people decided not to use fluoride. In other communities, people wanted it immediately.

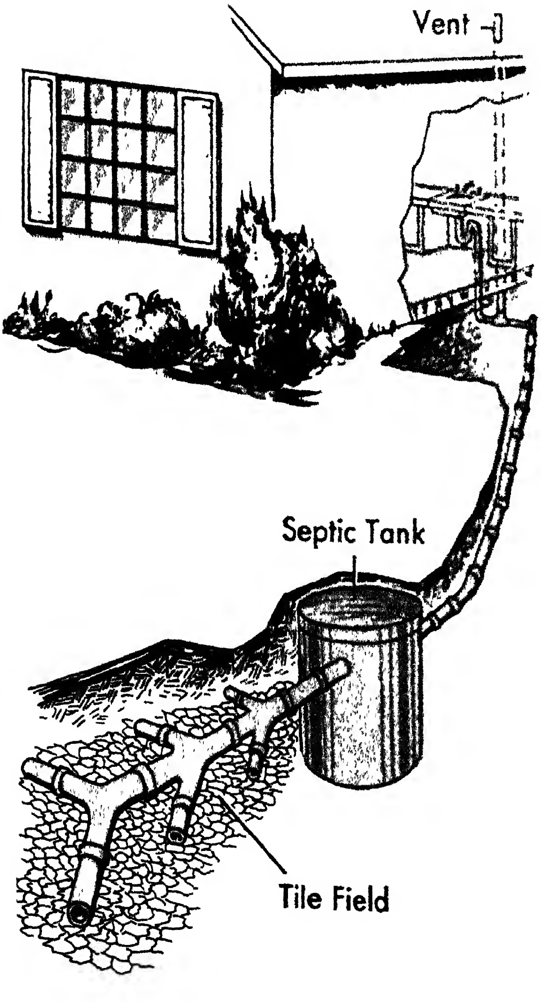
Some people objected to fluoride in the water supply because they said you could buy fluoride tablets in the drug store if you wanted them. A few people said that tooth decay is not a "catching" disease—like smallpox. They felt it wasn't right to make everyone drink the fluoride as everyone is forced to take a smallpox shot. What do you think of these arguments?

Usually there is a vote in each community to decide whether or not to add fluoride to the water. More communities add it every year.

Some places have no central sewage treatment plant. **Septic tanks** are buried in the ground near each house. The sewage drains from the house into the septic tank through a pipe.

Bacteria in these tanks feed on waste materials and decompose them. The liquid flows from the top of the tank into the soil. It does not contain much waste matter. As this liquid soaks through the soil, the remaining waste materials are filtered out by the soil. The liquid does not pollute the ground water unless there are many septic tanks in a small area.

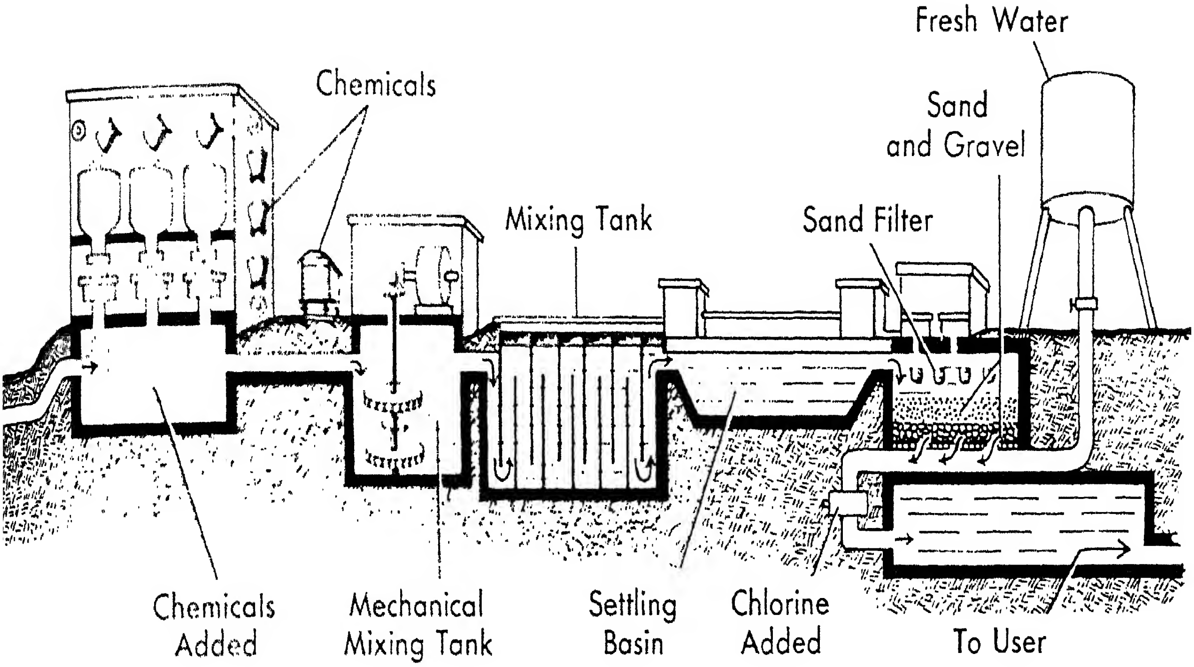




Treating the Drinking Water

Water from most rivers and lakes has to be treated in some way before it is safe to drink. It is treated to remove soil and other material and to kill harmful bacteria. The water is pumped into large settling tanks, in which certain chemicals are added to the water. The chemicals produce a cotton-like substance, which settles to the bottom. As it settles, it carries down with it most of the solid materials.

The clear water is then run into another tank called a sand filter. The bottom of this tank is covered with a thick layer of sand. As the water seeps through the sand, any remaining solid



material, including some bacteria, is removed. Then another chemical, chlorine, is added. Only enough chlorine is added to kill all remaining harmful bacteria and make the water safe to drink. You may be able to taste chlorine in water but it will not harm you.

Where ground water is used, it is not necessary to filter the water. It has already been filtered. Can you explain how?

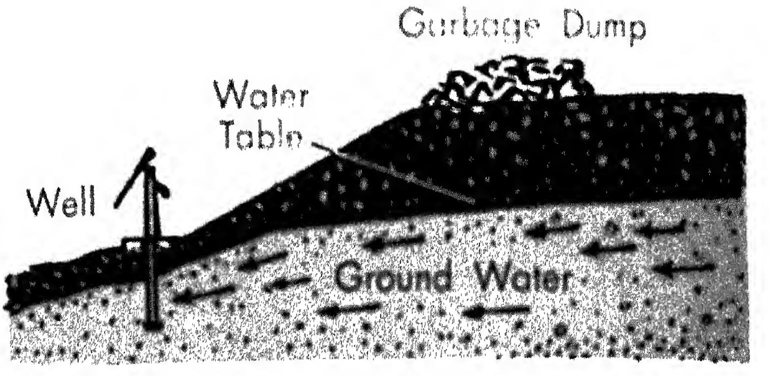
Things to Do

1. Bury a banana peel in an empty lot, or in your back yard. Mark the spot. Come back three weeks later to see what has happened to it.

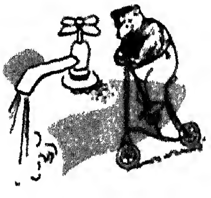
2. Find out how sewage is treated in your community. Are settling tanks used? What is done with the heavy sewage? Where is the liquid sewage released after treatment? Perhaps you can take a trip to the sewage treatment plant.

3. If your community uses ground water, find out from the water company where the pumping stations are. Ask the company why they are located in those particular spots.

4. Does your water company add chlorine to the water? Write to the company to find out.



Things to Talk About

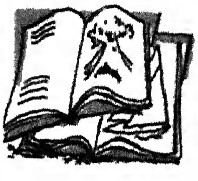


1. Is this a good place to drill a well? Why?

2. Why do people using septic tanks have to be careful sometimes about the amount of water they use?

3. Are there some uses of water you know about which have not been mentioned in this unit?

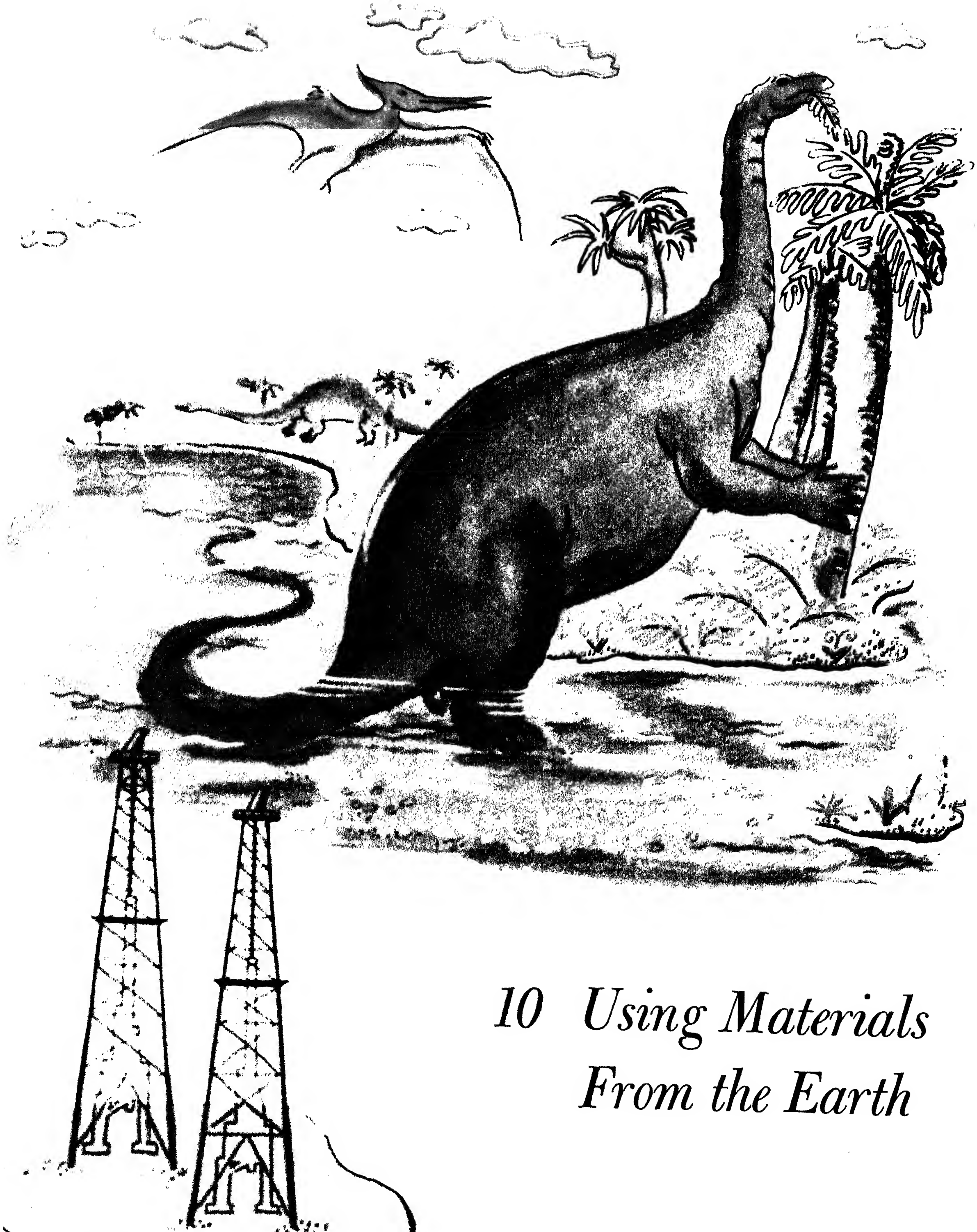
Things to Read About



1. Why is water sometimes sprayed into the air as a part of treating it for home use?

2. How can water containing chlorine be made safe for use in fish aquariums?

3. Ask your water company if there are special rules about using water in your community. Can lawns be sprinkled at any time? Are automatic lawn sprinklers permitted?



10 *Using Materials From the Earth*

About "*Using Materials From the Earth*"

Our home is the earth. As far as we know, it is the only planet that has all of the things we need to stay alive. It has air, water, and soil. It has green plants, which give us food. Without these things we could not live.

The earth supplies us with still other important materials that we have learned to use. Materials such as coal, oil, iron, and copper have become part of our daily lives. These materials and many others are found under the surface of the earth. We must dig and drill to get at them.

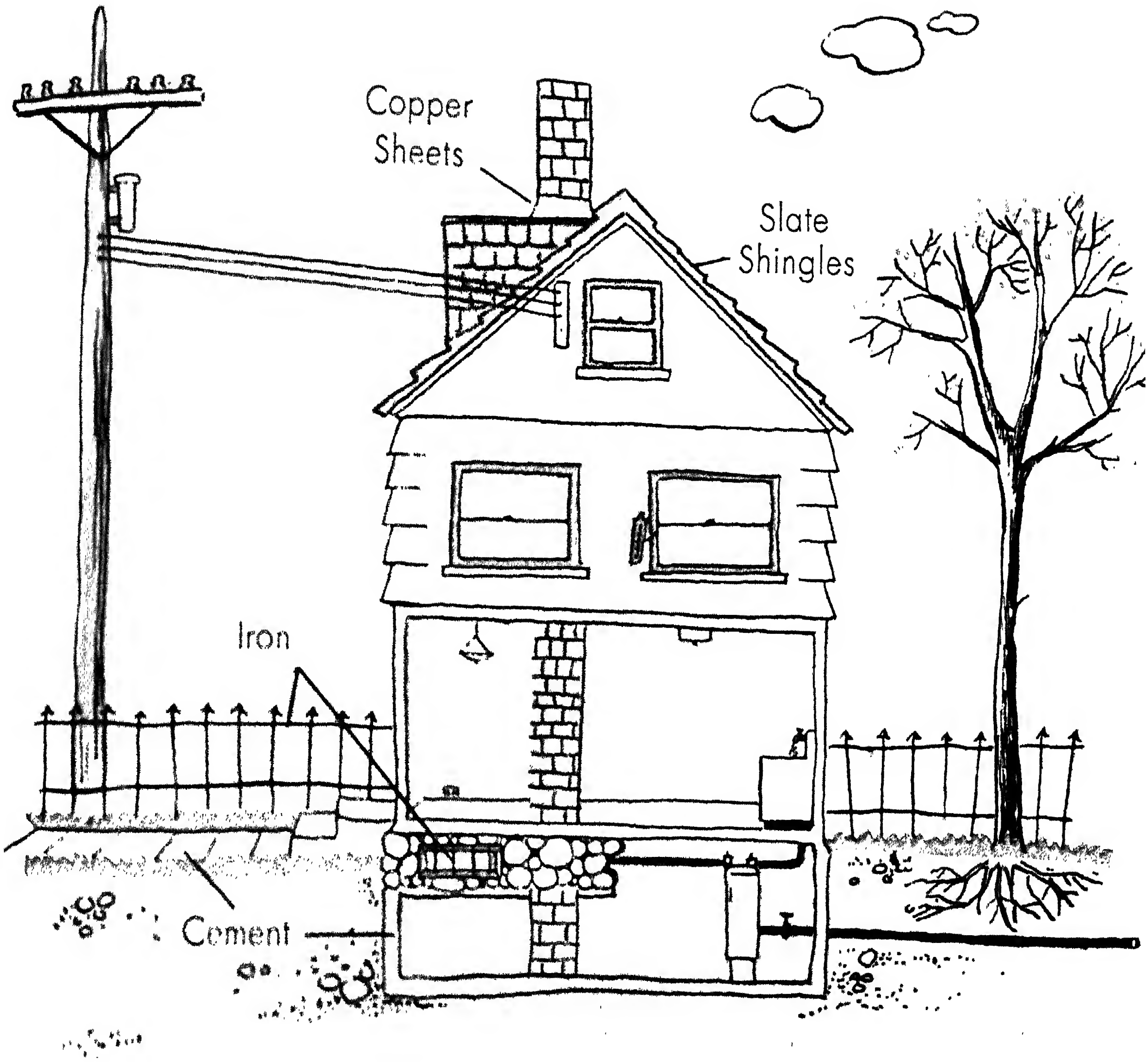
In this unit you will find out why these earth materials have become so important to us. You will find answers to questions such as these:

How were the materials formed?

How do we locate them?

How do we get them out of the earth?

How can we make better use of them?

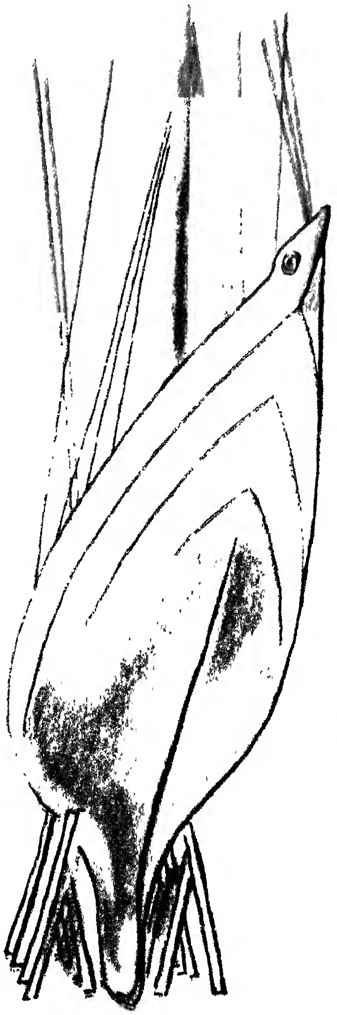
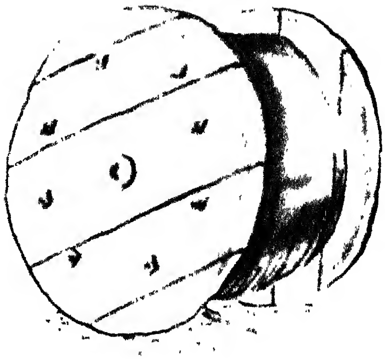
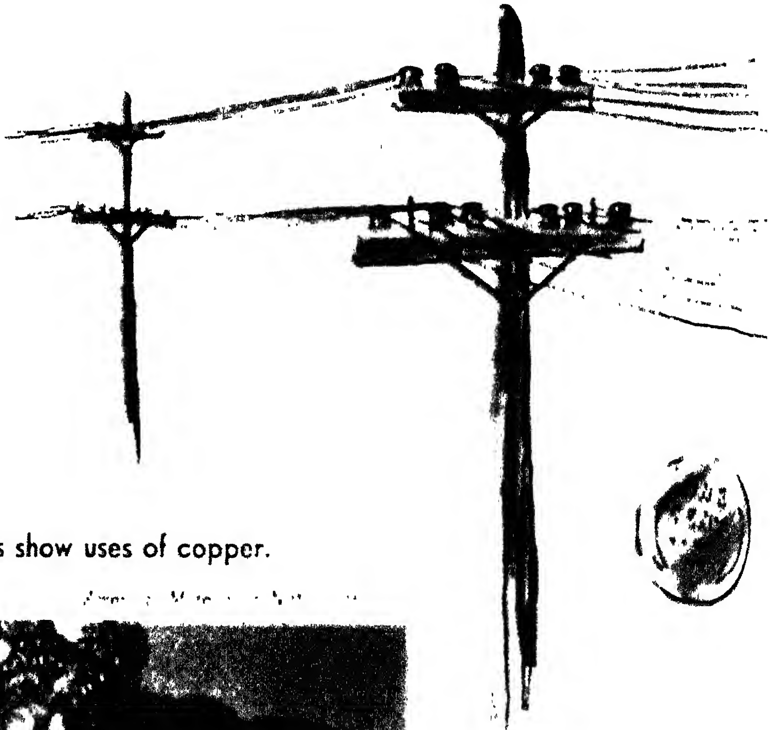


HOW WE USE MATERIALS FROM THE EARTH

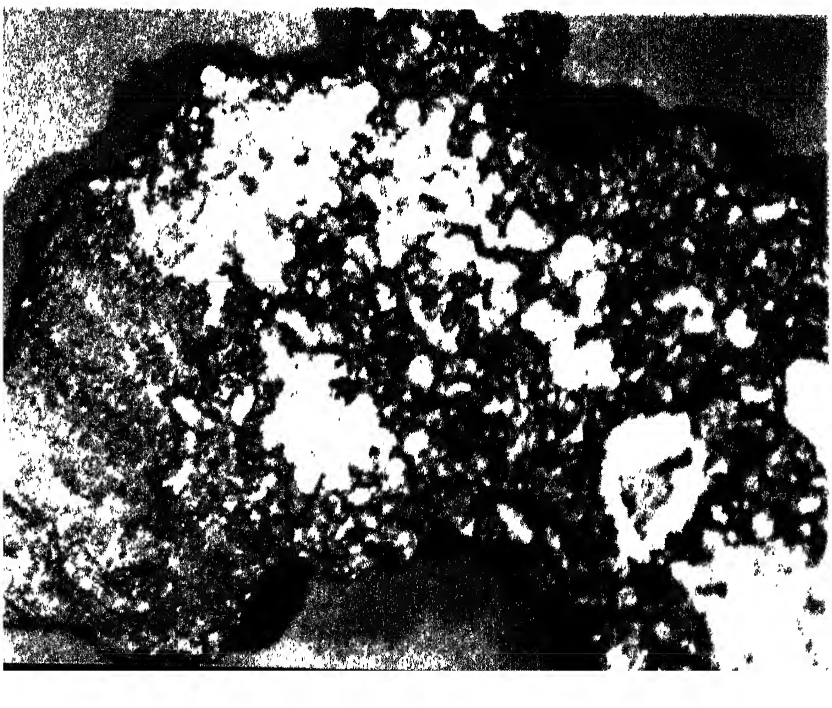
What is a house made of? Materials from the earth. We can begin with the windows. Glass is made from several earth materials, including sand and limestone. Why do we have windows in houses? The chief reason is to let in the light and air. But we also want to keep out the cold air, dust, and bugs. So we need something that will let light come through but keep out the other things.

We use copper wires to carry electricity into the house. Copper is a good conductor of electricity. Other metals, such as iron, will conduct electricity, too. But do they do it as well as copper?

You can compare copper wire and iron wire in this way. Arrange a dry

Copper ore. The drawings show uses of copper.




cell and an electric light as shown in the drawing. Cut two pieces of copper wire about ten inches long. Make loops at the ends to connect the dry cell and the light. Now you have a closed circuit. Notice how bright the light is. Now cut two pieces of iron wire about ten inches long and of about the same thickness as the copper wire. Connect them to the dry cell and to the light. Notice how bright the light is now. Which wire is better for conducting electricity? Was this a fair comparison?

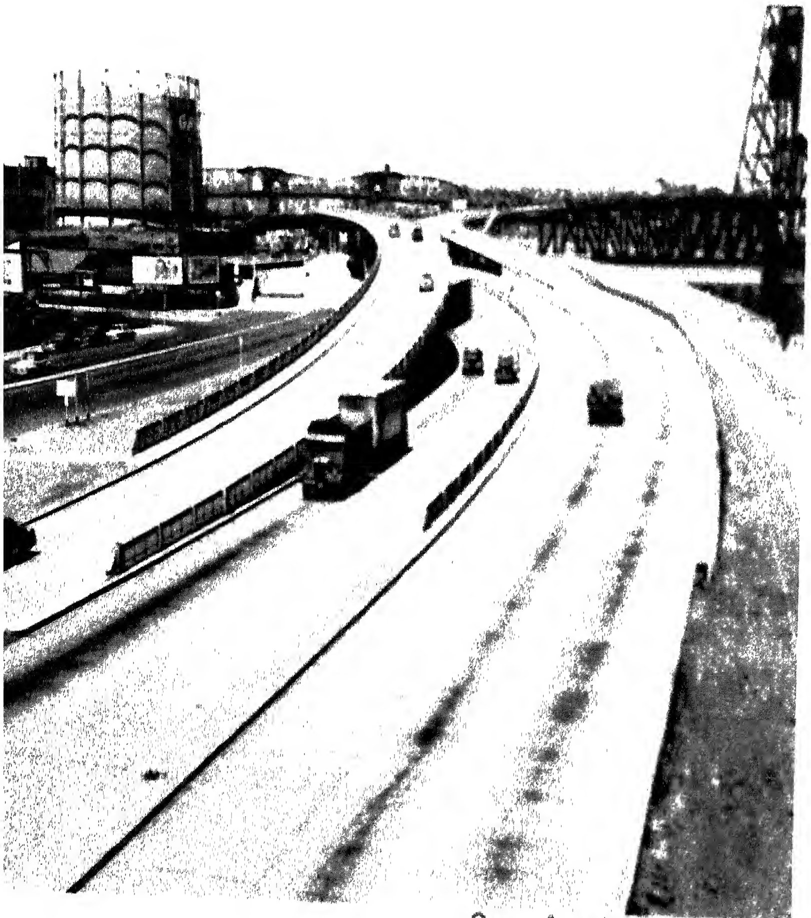
As you cut and looped the copper and iron wire, you probably noticed that the copper wire bent more easily than the iron wire.

Take another look at the house on page 251. Notice where the copper sheets are used on the roof? In these places it would be difficult to use shingles. Sheets of iron could have been used. But copper is generally used because it does not rust as iron does. You can do an experiment to show this.

Cut a piece of iron wire 4 inches long. Cut a piece of copper wire the same length. Rub each piece with sand paper until it is shiny. Loop one end of each wire and tie a string onto it. Wet each wire and hang it in a covered water glass that has about an inch of water in the bottom. Compare the two wires after several days.

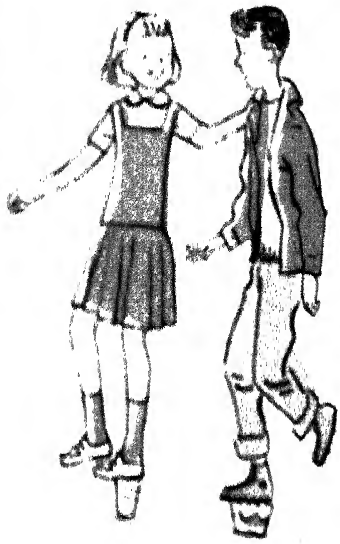
As you know, the oxygen from the air combines with iron to form rust. The iron will continue to rust until there is no more iron. Oxygen also combines with copper. But instead of rust, a thin green coating forms. This green coating keeps the copper under it from combining further with oxygen.

Copper is also used for water pipes. Can you explain why copper pipes would be better than iron ones? What other things that you know about are made of copper? Why is copper used for each of them?



Oregon State Highway Commission

Highways are made of concrete. They can stand the weight of heavy traffic.



Cement

The foundation and sidewalks of the house on page 251 are made with cement. Cement is one of our most important building materials. It is made from a mixture of two earth materials, limestone and clay.

Here is something you can do to find out why cement is such an important building material. Mix one part of cement with four parts of sand and gravel. Add enough water to make the mixture muddy. This mixture is called concrete. Pour the concrete into paper cups of different sizes and shapes. Let them stand until the concrete is dry and hard. Test the strength of your concrete by seeing how much weight it will hold. Use different members of your class as weights. Can you explain now why concrete is used for sidewalks and foundations? Can you think of other places where cement is used?

Mercury

The thermometer hanging outside the house is a mercury thermometer. Mercury is a liquid metal obtained from certain minerals in the earth. The material in a thermometer has to be liquid so it can flow up and down as it expands and contracts. Water could be used in a thermometer. But water freezes at 32° F. You can see why it would be a poor idea to use water in thermometers. Mercury doesn't freeze until the temperature is about 40° below zero.

Iron

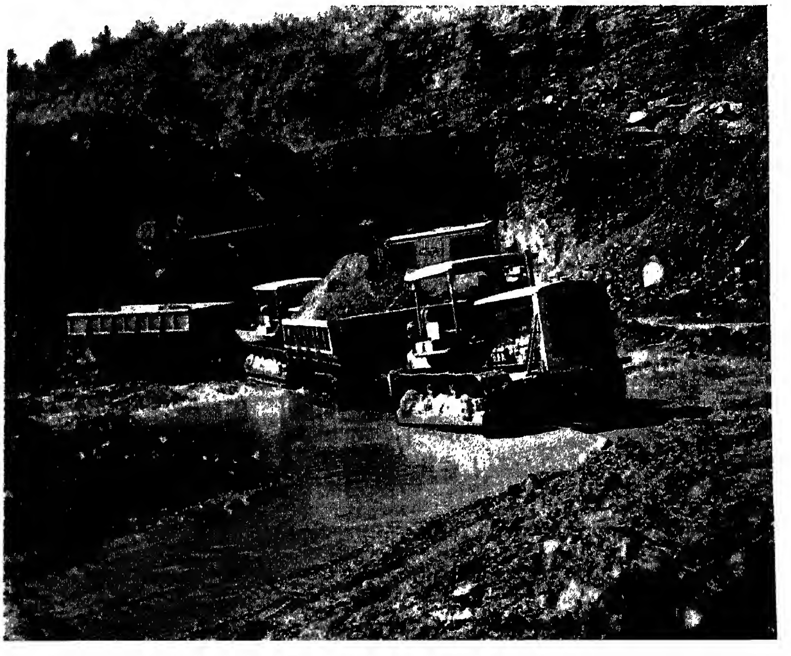
Find the places where iron is used in the house on page 251. These are only a few of the many ways that we use iron. Most of the metal parts of your bicycle are made from iron. Iron is used to make things that we want to be tough and strong. We get iron from minerals in the earth, too.

Slate

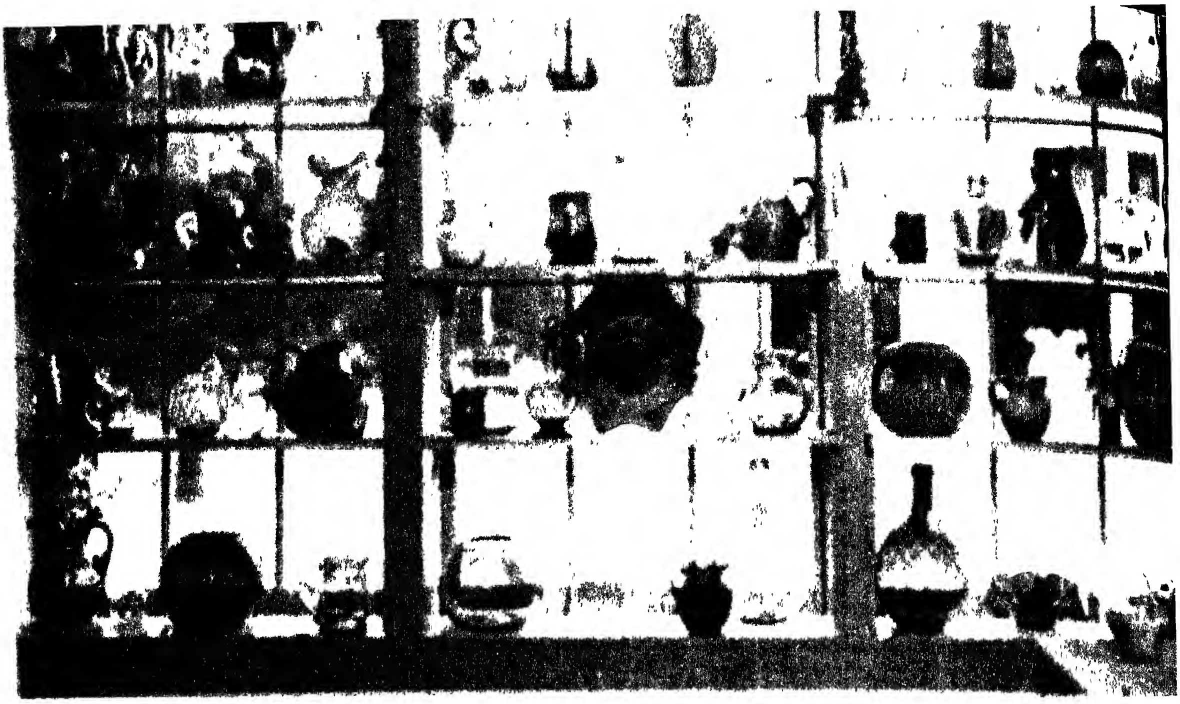
The roof of a house must protect everything underneath it. Rain, snow, and hail fall upon it. The water must drain off without leaking through. In the winter, snow may pile up and freeze on it. In the summer, the sun makes the roof very hot. The house on page 251 is covered with slate shingles.

Slate is a rock taken from the earth. It can be removed in thin sheets and cut into different shapes. Your chalkboard may be made of slate. Slate shingles last a long time. They do not wear out as many other kinds of shingles do. If you can get a slate shingle, compare it with other kinds of shingles. Which one is hardest? Which one will burn? Which one breaks most easily when dropped?

Caterpillar Tractor Co.



Tractors hauling ore from an iron mine to the railroad



What properties of glass does this picture show?

Materials for Different Uses

Each kind of material used in building a house is chosen for a reason. Glass lets light pass through it. Copper conducts electricity well. Concrete is strong. Each of these materials was chosen for certain **properties** it has. In science the word **property** is used to describe what different materials are like. For example, one of the properties of glass is that light will go through it. Another property of glass is that it can be melted and formed into different shapes. Glass will not conduct electricity. It is brittle and will break easily when dropped. These are some of the properties of glass. What are some of the properties of copper? Of mercury? Of concrete?

Similarities of Metals

You have probably used the word *metal* many times. You have used it in naming materials. But what *are* metals? In answering this question you would probably say that iron is a metal and you would be right. Copper and mercury are also metals. So are aluminum, gold, and silver. But how are metals different from other materials?

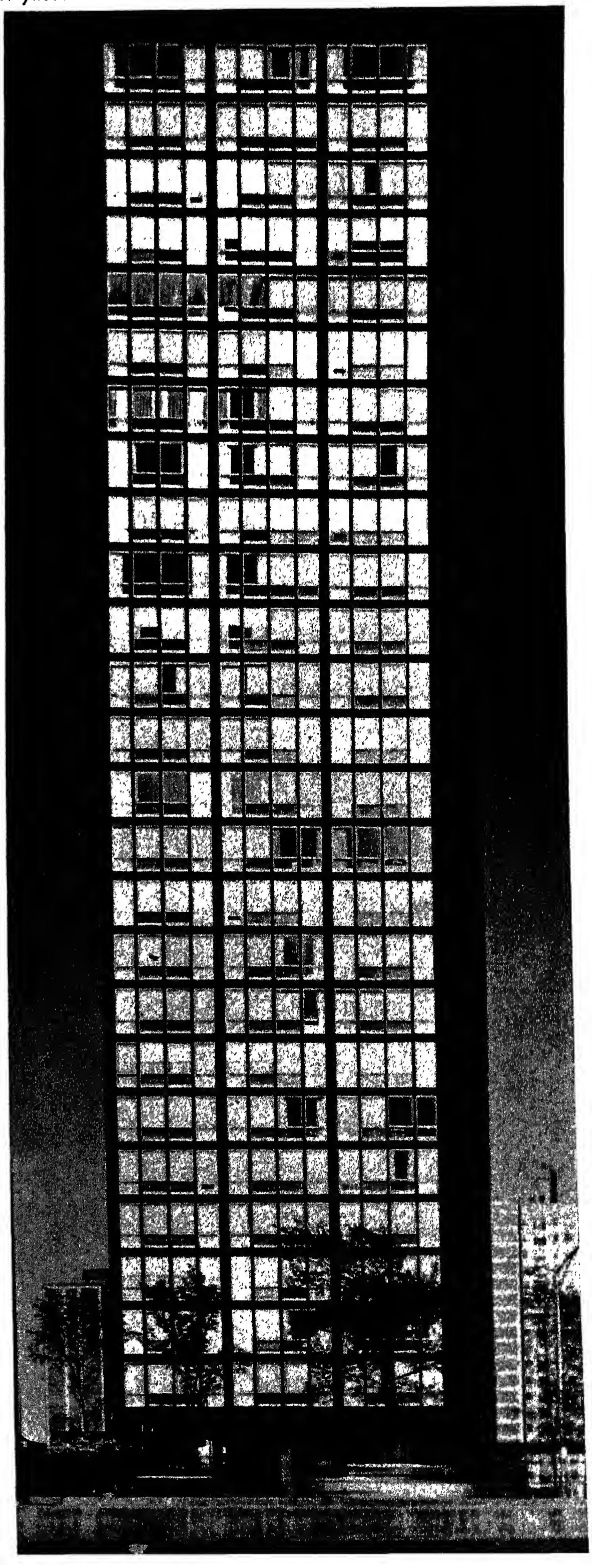
There are certain properties that all metals have. How could you describe their appearance? The chemist says they all have a shine. Examine as many different metals as you can find. Do they have a shine? You may have to scrape some of them to see what they really look like underneath their outer coating.

The chemist also says metals will conduct electricity. You have already tested copper and iron, and found copper to be a better conductor. Find objects made of gold, silver, and aluminum. Test them with your dry cell and lamp to see if they will conduct electricity. How could you test mercury?

Metals are good conductors of heat. How could you do an experiment to find out which one is the best conductor of heat? All metals except mercury can be hammered into sheets and drawn into wires. Because metals have properties like these, we have found many ways to use them.

It takes many materials to build a skyscraper. In this building, aluminum was used to frame the many windows.

Reynolds Metals Co.



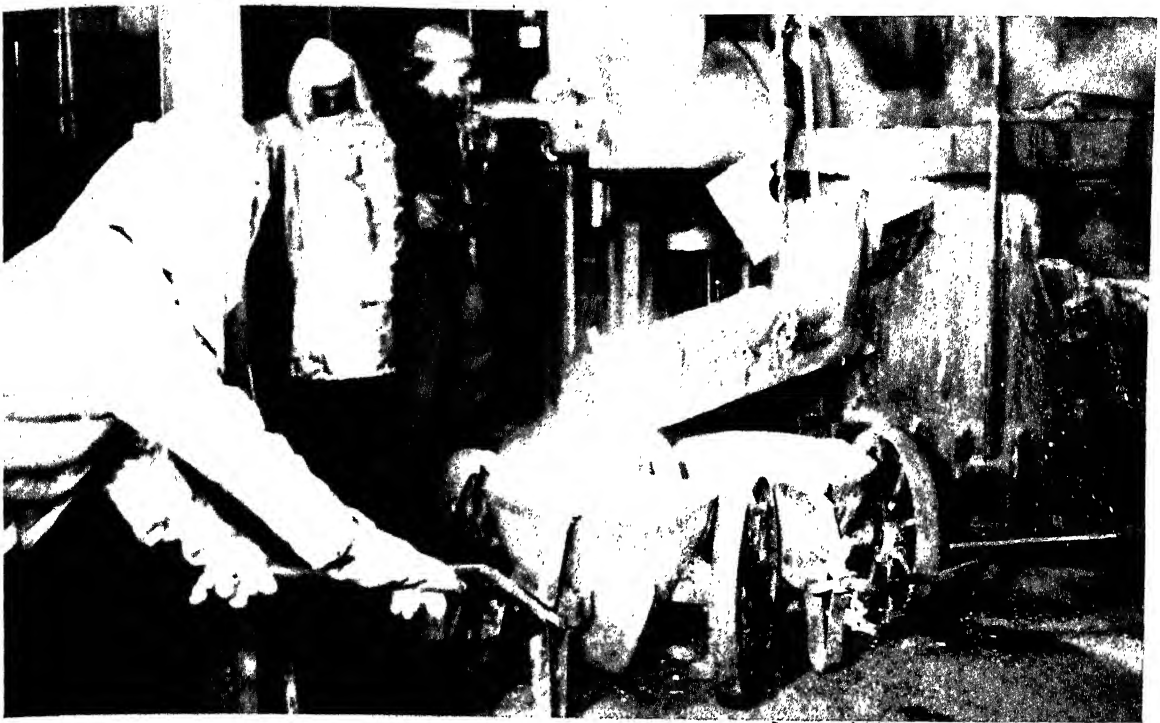
Differences of Metals

You have already seen some of the ways copper and iron are different. How are copper and gold different? Gold is the more expensive because it is not as plentiful as copper. A gold finger ring is worth more than a copper ring. But there is another reason why gold is used in rings. Make a ring for yourself out of a thick piece of copper wire. If you wear it for several days, it will make a green line around your finger. Some of the copper combines with chemicals in the air to form a green chemical compound, which rubs off on your finger. Gold will not do this. Can you see one reason the dentist uses gold rather than copper to fill teeth?

Can you tell how aluminum is different from such metals as copper and iron? Try to get some aluminum and iron bottle caps, spoons, or pans. Which ones are heavier? Aluminum is very light compared with some of the other metals. It is used in airplanes and other things where a light but strong metal is needed.

Aluminum is one of the most important metals in modern aircraft.

Convair



Bureau of Mines, U. S. Dept. of Interior

This is a metal laboratory. The scientists use this blast furnace to test new ways of working with steel.

Mixtures of Metals

Some metals are more useful when mixed with other chemicals. To mix them, the metals have to be melted in very hot furnaces. As in making a cake, just the right amount of each material must be mixed.

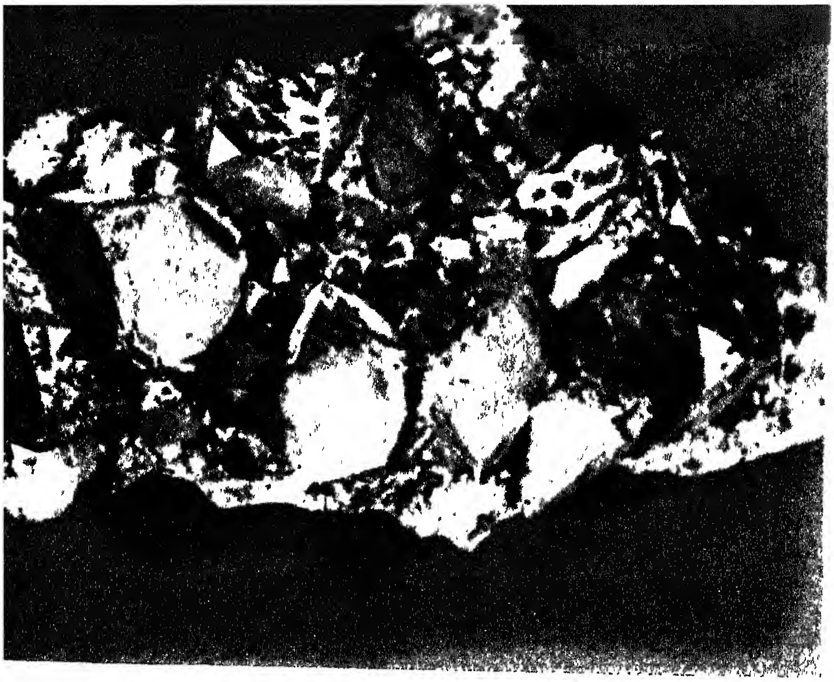
Steel is a mixture of iron and carbon. Most of the mixture is iron. Steel is stronger than iron alone and can be used in many more ways. Nails, wire, bridges, automobiles, knives, and scissors are made from steel. The bumper on your father's car is made from steel. So are the handle bars on your bike.

Because steel is mostly iron, it has to be kept from rusting. How are bridges and cars kept from rusting?

Do you have anything around your home made of stainless steel? Stainless steel is a special steel mixture that will not rust.

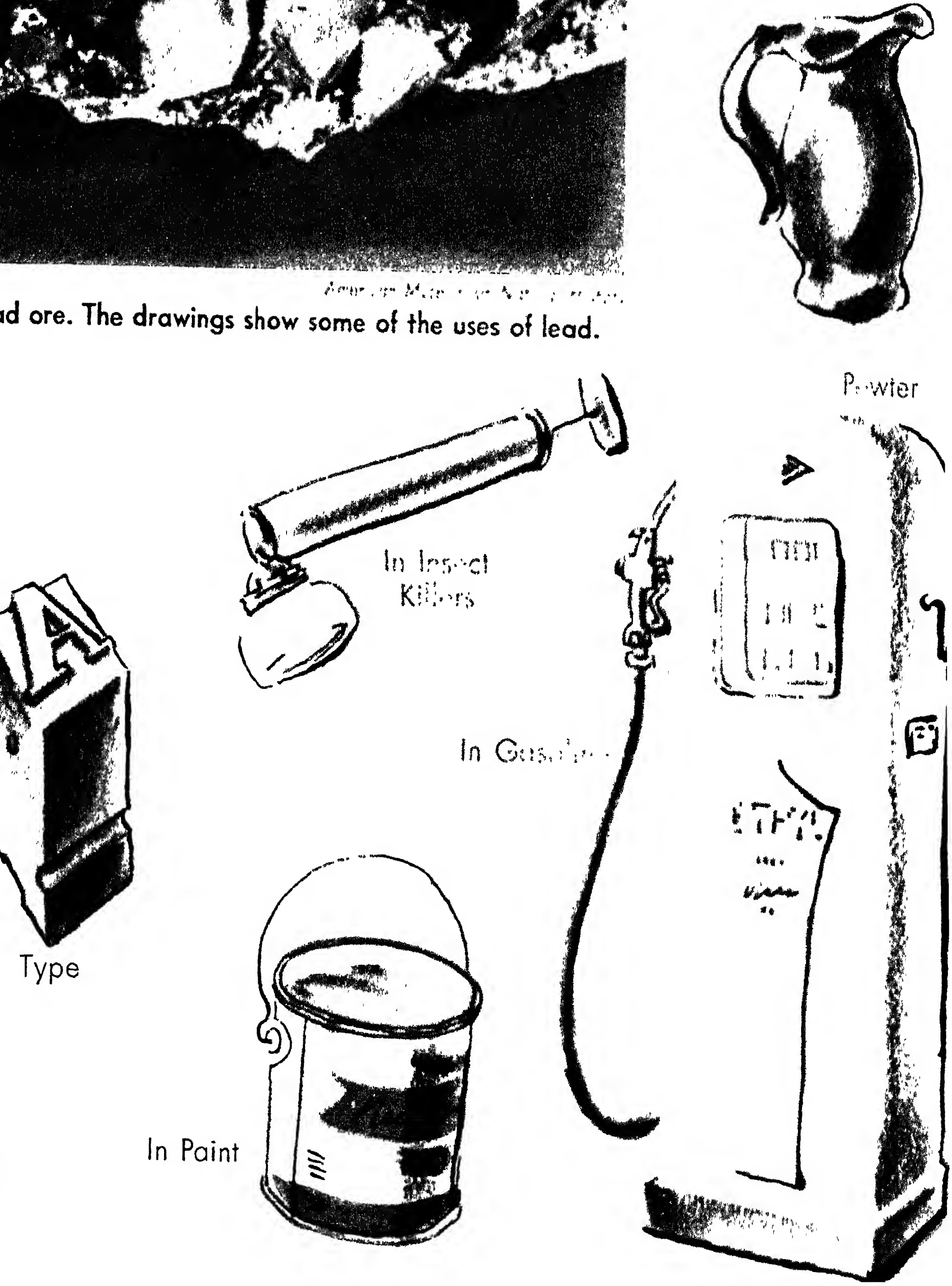
Look at a dime. What kind of metal is it? It is a mixture of copper and silver. Pennies are mixtures of copper, zinc, and tin. Copper alone would be too soft. It would dent and bend too easily.

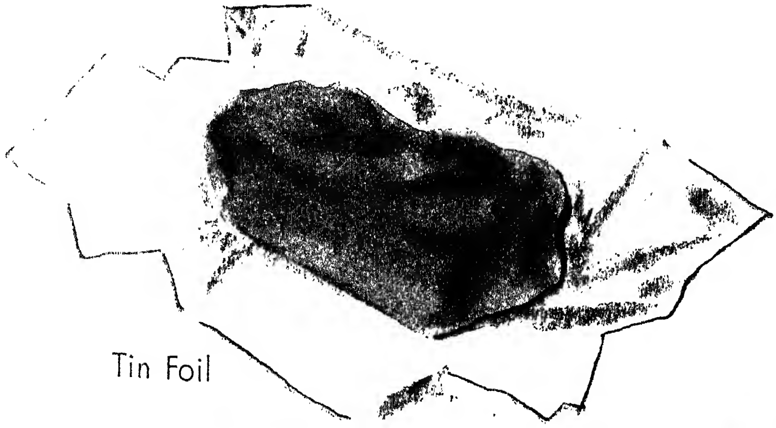
Many chemists are hard at work trying to find new mixtures of metals that will work better than the old ones. With their wide knowledge of metals and other chemicals, they develop ideas about how to make new mixtures. They make them and test them. They get thousands of ideas but only a few pass the test.

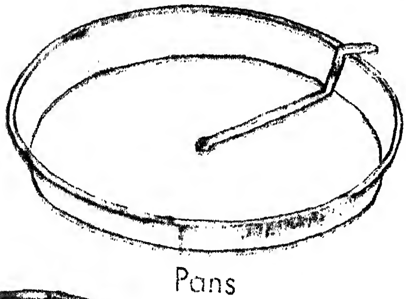


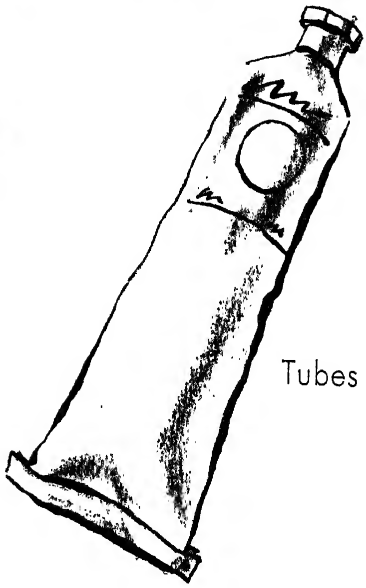
American Museum of Natural History

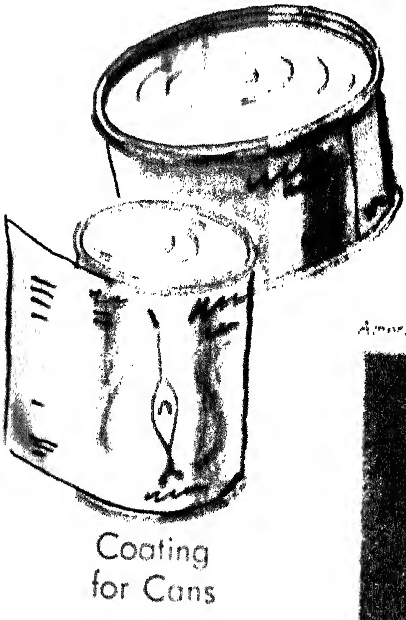
Lead ore. The drawings show some of the uses of lead.





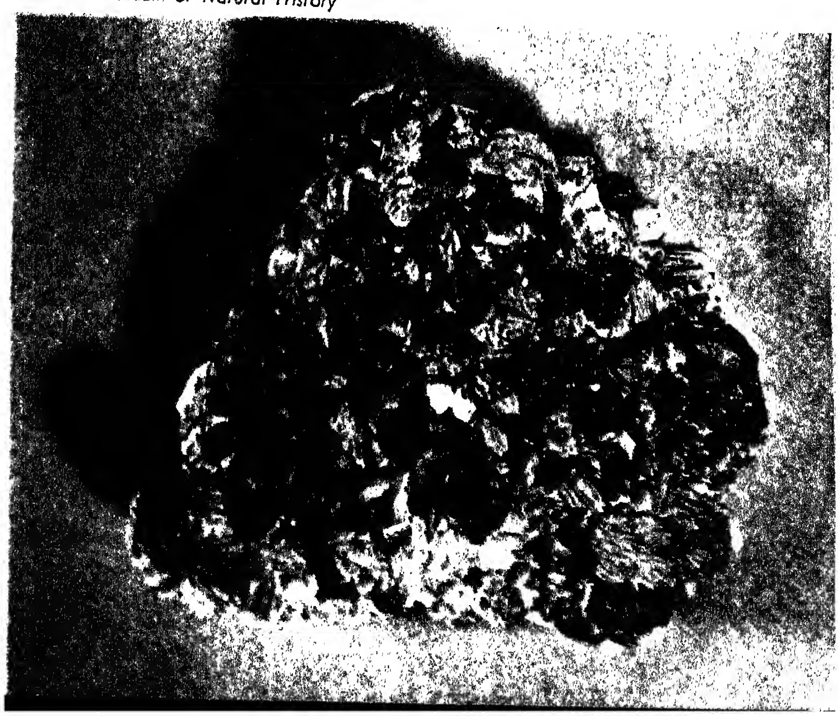




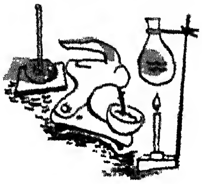


Tin ore. The drawings show some of the uses of tin.

American Museum of Natural History



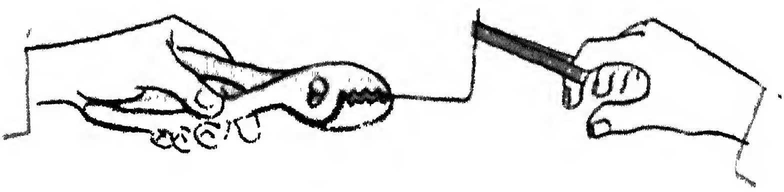
Things to Do



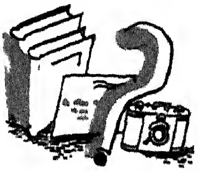
1. Examine the bumpers on some cars and the handle bars on bikes. Do you find any rusty places? Can you tell why those places got rusty?

2. Find out whether iron or copper is a better conductor of heat. With one hand hold the tip of a copper wire in a candle flame. With the other hand hold the tip of an iron wire in the same flame. In which hand does the wire get hot first? What must you do to make this a fair comparison? How could you use hot water, a silver spoon, and a stainless steel spoon to tell which conducts heat better?

3. Bend a copper wire with your fingers. Now bend an iron wire of the same size. You could feel that the copper wire bent easily. Now hold each piece of wire with a pair of pliers. Use a rubber band to prove copper wire bends easier. Measure with a ruler the amount of stretch it took to bend each wire.



If You Want to Find Out More



Tin cans are made of steel. Get two small tin cans right after they have been opened. Wash them and examine each one. Can you tell why they are not rusty? Now fill two larger cans half way with water and place a piece of screen over the tops of them. Scratch the outside of one of the small cans in a number of places. Then place both small cans on top of the screens covering the larger cans. Now place another large can over each of the smaller ones. Look at the cans every day. Which one begins to rust first? Where does it get rusty? Why were the smaller cans arranged in this way? What was scratched off the outside of the can?

HOW EARTH MATERIALS WERE FORMED

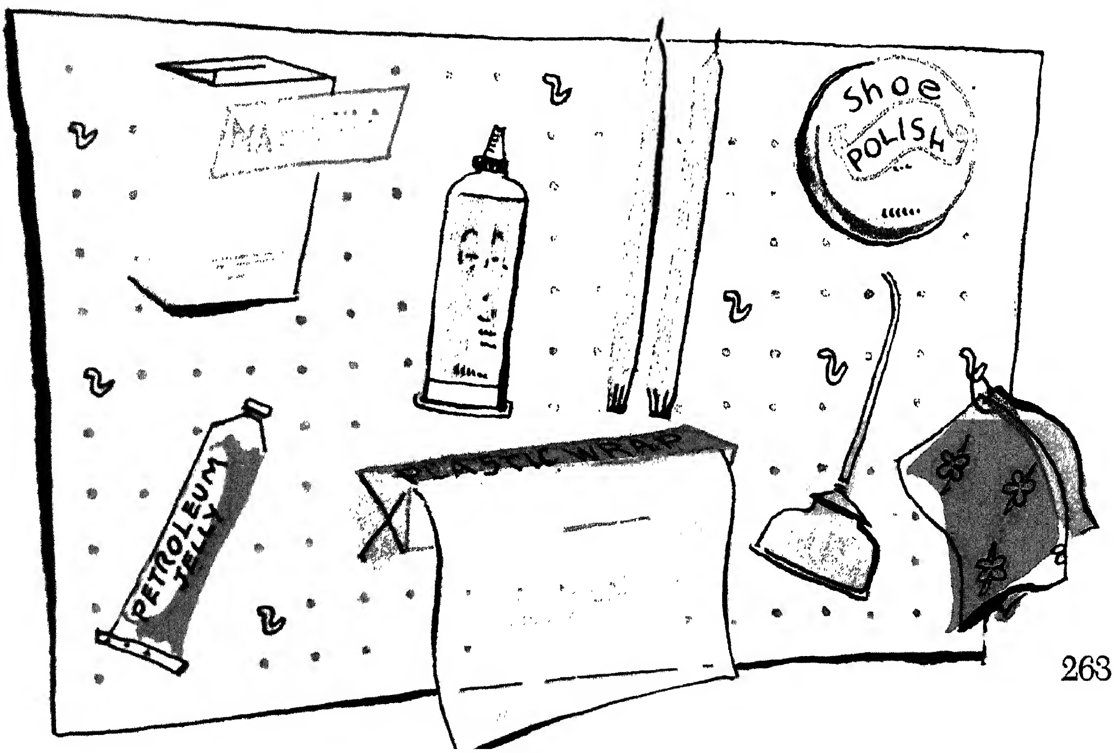
It is believed that the earth was formed from materials like those that formed the sun. If this is true, then all metals and other elements in the earth must have come from these materials. Over the millions of years the earth has changed in many ways. As a result of these changes, the metals combined with other elements to form many different compounds. For example, iron and aluminum are generally combined with oxygen. Copper is sometimes found in a compound with sulfur. The metal compounds are usually found along with other materials in rocks. Rocks and other materials from which we get metals are called **ores.** Only a few metals are found pure in the earth.

Coal, oil, and gas are another group of important materials that we get from the earth. One important property of these materials is that all of them will burn. Because they will burn, they furnish us with heat—for warmth, for cooking, for running machines.

Before coal was discovered, wood was the most important fuel. But coal is a better fuel than wood in many ways. It burns with a hotter flame, and it will burn for a longer time.

Many different things are made from the oil that we get from the earth. Gasoline for cars, kerosene for stoves, and wax for making candles are only a few of them. Chemists have made many others as shown in the picture.

Perhaps you could make a display like this one for your classroom.



How Coal Was Formed

Millions of years ago the earth was much warmer than it is today. Swamps covered much of the land. The plants were not like most of those you see today. They resembled giant ferns. Some of them were 200 feet tall.

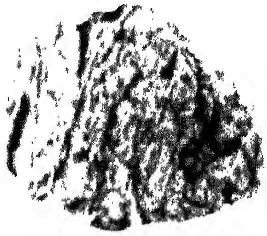
As the plants died, they fell to the bottom of the swamps, forming thick layers of dead material. As time passed, the layers of dead plants partly decomposed to form a substance we call **peat**. Peat is used as a fuel in some parts of the world.

Over the ages, the crust of the earth was pushed up in some places and lowered in others. The sea moved in over these swamps. Layers of mud and other materials slowly settled over the peat. As layer after layer settled, the peat was pressed deeper and deeper into the earth. The peat dried, hardened, and changed to **lignite**, a form of coal. Lignite is a better fuel than peat.

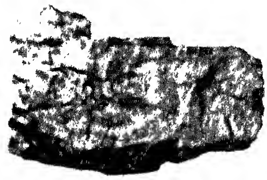
In time, the lignite changed to "soft" coal, also called **bituminous** coal. As the layers of mud and other materials pressed some of the soft coal even deeper into the earth, it changed to hard coal. Hard coal is called **anthracite.**

You can see that coal is a kind of sedimentary rock formed by layers of certain materials under water. But, unlike most other sedimentary rock, the material in coal was once alive. The imprint of plants that lived millions of years ago can be seen in some lumps of coal.

Peat bog



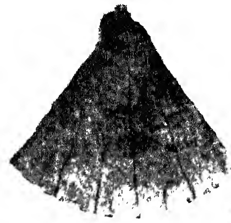
Peat



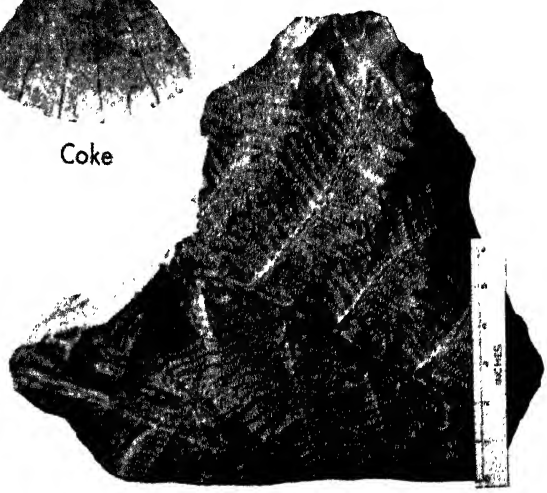
Lignite

Bituminous

Anthracite

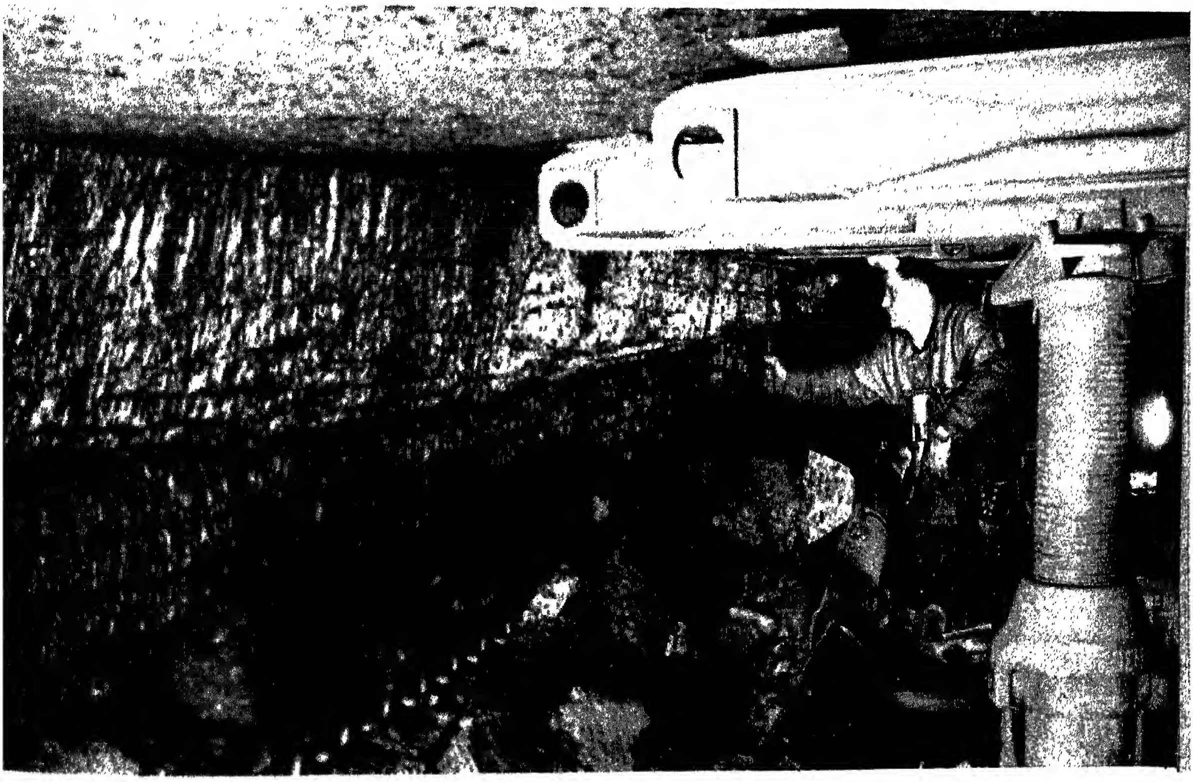


Coke



Above: Various kinds of coal. *Right:* This imprint of plants that lived millions of years ago was found in an anthracite mine in Pennsylvania. *Below:* Inside a coal mine

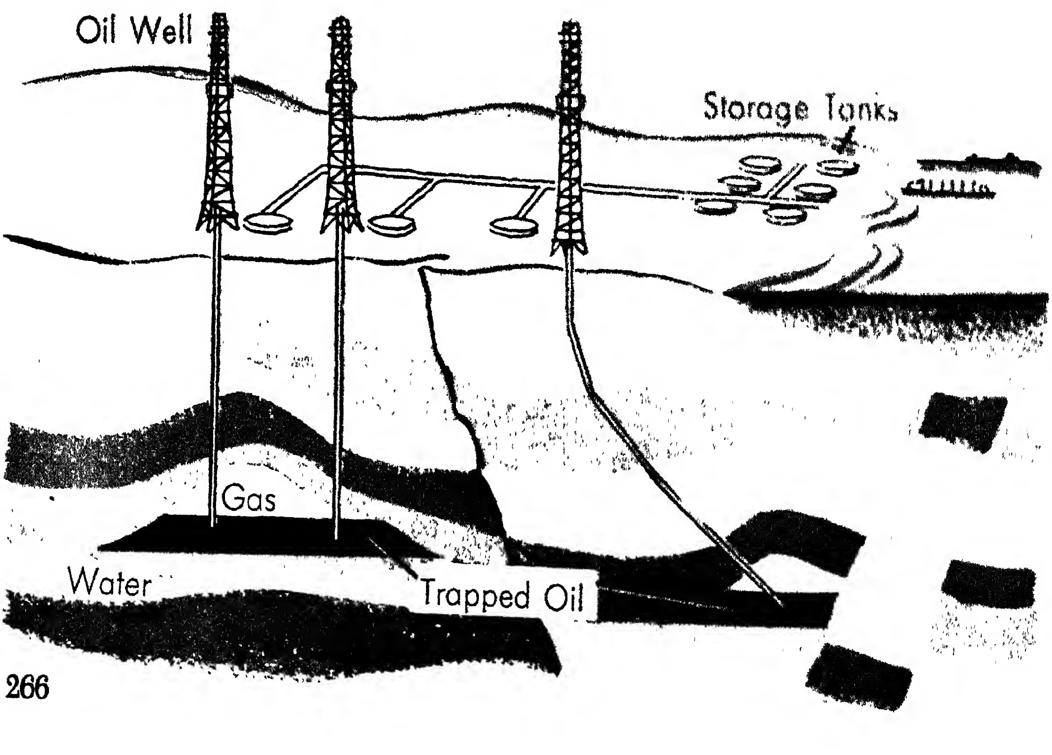
Photos, Bureau of Mines, U. S. Dept. of Interior



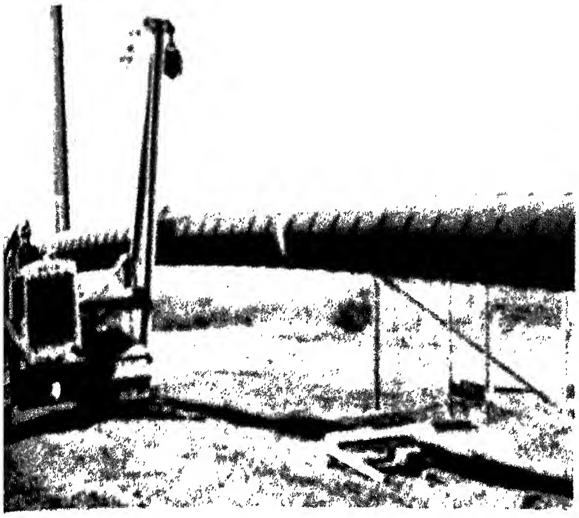
American Petroleum Institute

Caterpillar Tractor Co.

A comparison. The sand in the right hand is rich in oil. The sand in the left hand has no oil in it. Below is a diagram of an oil field.



From the oil fields, oil is carried for hundreds of miles in pipelines like these. Oil is stored in huge tanks.



Standard Oil Co. (N. J.)

How Oil Was Formed

Scientists think that oil was formed the same way coal was formed—except that oil comes from microscopic plants and animals that once lived in the sea. Certain ocean areas were once thick with this microscopic life.

As this thick mass of life died, it settled to the bottom of the ocean. Deep layers of decaying material formed. The layers were sometimes hundreds of feet deep.

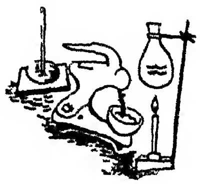
Mud and other materials from the ocean settled on top of these layers. These new layers—and the weight of the ocean—pressed on the dead plant and animal material below. Over the ages, the covering layers of mud became hard and turned to rock.

The layers of dead plants and animals gradually changed to oil because of the pressure of the rock and water above them. When oil is found today, it is always found in places that were once below the sea. You can tell a place was once under the sea by the type of rock found there.

Another fuel that comes from the earth is natural gas. Natural gas is always found near coal or oil deposits. It is formed from decaying plant and animal life, just as coal and oil are.

Thus, all the fuels you have read about were formed from living material—either plant or animal. And all green plants receive their energy from the sun. Animals depend on the sun's energy, too, since they live on green plants. All fuels used on the earth were at one time formed, from some of the chemical elements on the earth.

Things to Do



1. Make a chart showing the type of life that lived on the earth during past ages. Look in the encyclopedia under "Prehistoric Life." How long ago did the plants live that furnish today's coal supply?

2. Are there any mines in your state? What kind are they? How do they get the material out of them? To find out, write to the department in your state that knows about mines.

3. How many different kinds of coal are used in your town? Have a committee visit a local coal dealer and find out. Perhaps the members can get samples of different kinds. Explain why there are different kinds of coal.

4. Can you lay out a model on the playground that will help you see how thin the earth's crust is? Have someone stand in the center of the playground. Have him hold a string 40 feet long. Now have another person hold the other end of the string. Have them pull the string tightly. Let this be the distance, 4,000 miles, from the surface to the center of the earth. Now tie a ribbon on the string 5 inches from the end. This is the thickness of the earth's outer shell of rock. If you could divide these 5 inches into 40 equal parts, $\frac{1}{8}$ of an inch, one of these parts would be the depth of our deepest mine. Three of these will be how far the deepest oil well has been drilled into the earth.

Scientists believe that the earth was once very hot. As it cooled, its surface cracked and wrinkled. Life first began in water. Living things then appeared on land.

Things to Talk About

1. Wood is a common fuel in many places. Can you explain how wood is formed from the energy of the sun?

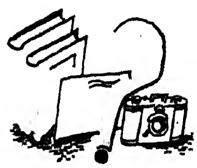
2. Metals are found most often in mountain areas. Why?

Things to Read About

1. Look up *iron* in an encyclopedia. Perhaps someone in your class can make a report on how iron ores were formed.

2. Where does most of the world's oil come from? Look up *oil* in an encyclopedia to find out. What does this tell you about changes that must have taken place in these parts of the earth?

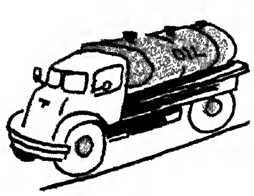
If You Want to Find Out More

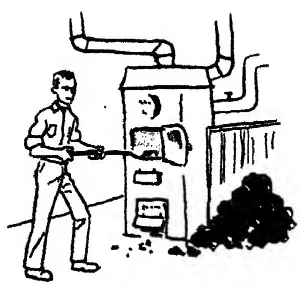


1. Look up *oil wells* in an encyclopedia. Find out how a well is drilled. How long does it take? How much does it cost? Is oil always found?

2. Uranium is the fuel used for atomic energy. Do you know how it is located? People searching for uranium use a special instrument called a radiation counter. Perhaps you have heard it called a Geiger counter. If you have a Geiger counter or can borrow one, try this. Take a watch that you can see in the dark, and check it with the counter. Now have someone hide the watch and see if you can find it by using the counter.

Today, man mines and uses materials that were formed millions of years ago.





CONSERVING MATERIALS IN THE EARTH

Minerals are not spread evenly through the earth's crust. Oil is found only in certain sections that were once under the sea. Coal is found only where there was once thick swampland. Ore is found only in certain places. As a result, some countries are richer in certain resources than other countries.

No nation has within its own borders the materials to manufacture all the products it needs. Each country depends on others.

Even if materials from the earth were evenly distributed through the earth's crust, men would have to be careful not to waste them. When the earth was formed, it contained certain amounts of each metal. These amounts can never be changed. No new metal can come from the earth that was not there when the earth was formed.

Our mineral wealth is not like lumber, water, grassland, and wildlife, which can be built up if necessary. Metals and most fuels once used can never be replaced.

Coal took millions of years to form. Once we use all the coal in the earth's crust, it will be impossible to find or make more. Oil must also be used carefully.

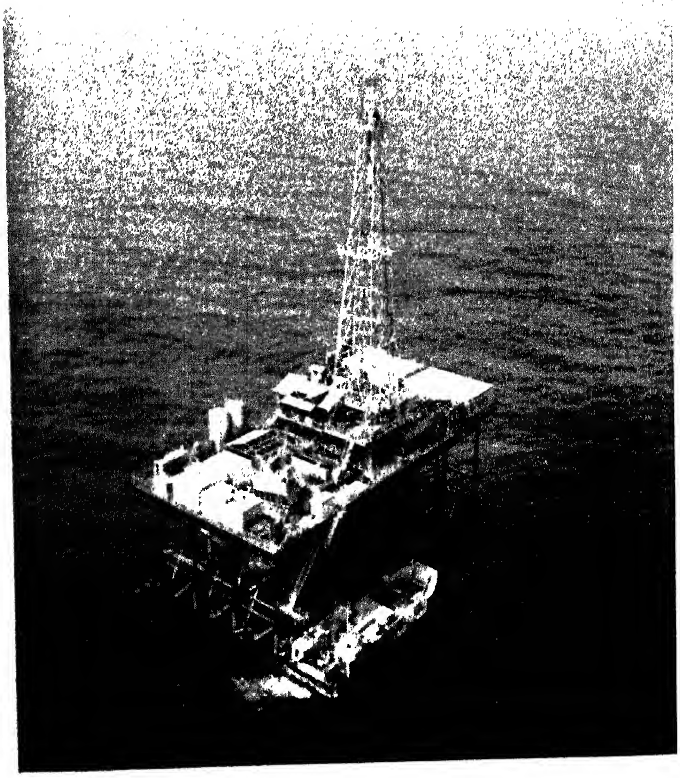
Most metals and fuels have been used at a rapid rate. In 1893, the huge iron ore mines in northern Minnesota—in the famous Mesabi range—were opened. By 1934, almost half of the ore was dug out of these mines. The town of Hibbing, Minnesota, at the center of the Mesabi range, had to be moved so that iron ore could be dug out where the houses once stood.

The same story can be told about fuels. About one-third of all the anthracite coal in this country has already been removed from the earth. Many oil wells have run dry.

A few minerals like coal can probably be used at a high rate for a very long time with little danger of their running out. There is so much coal in the United States that we will probably find new fuels to replace coal before we use up the coal we have. But although the United States has all the coal it needs, it does not have unlimited amounts of the best coal—anthracite. Even a plentiful substance like coal must be conserved.

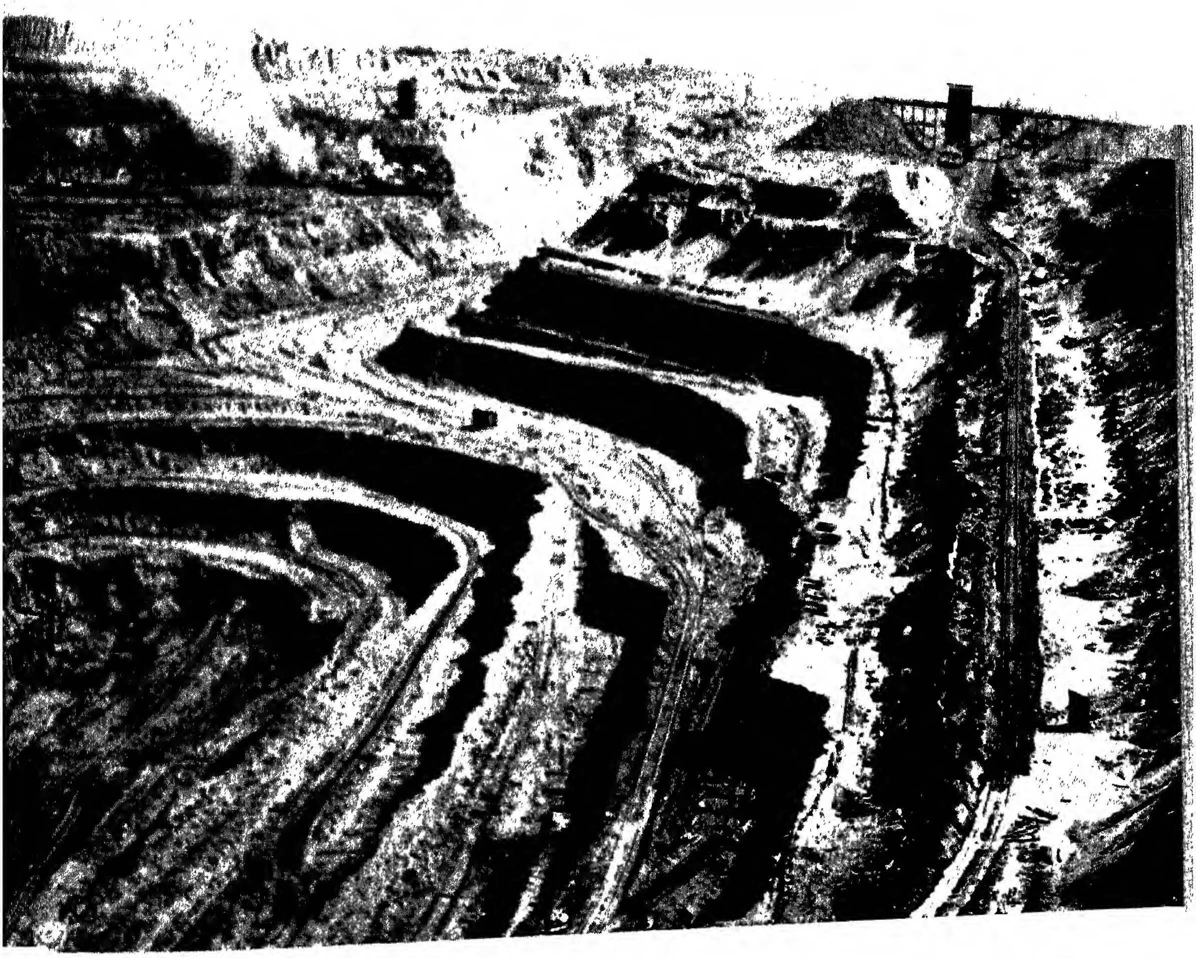
The oil in our underground pools will run out in about 100 years if we keep using oil at the present rate. However, new pools have been discovered under the ocean near our shores. Scientists believe that many more new pools will be discovered, too. Also, new ways of producing oil from other substances may be discovered in years to come.

Cities Service Co.



Below: The open-pit iron mine at Hibbing, Minnesota. *Right:* Off-shore drilling is one way of increasing our oil supply.

Ewing Galloway



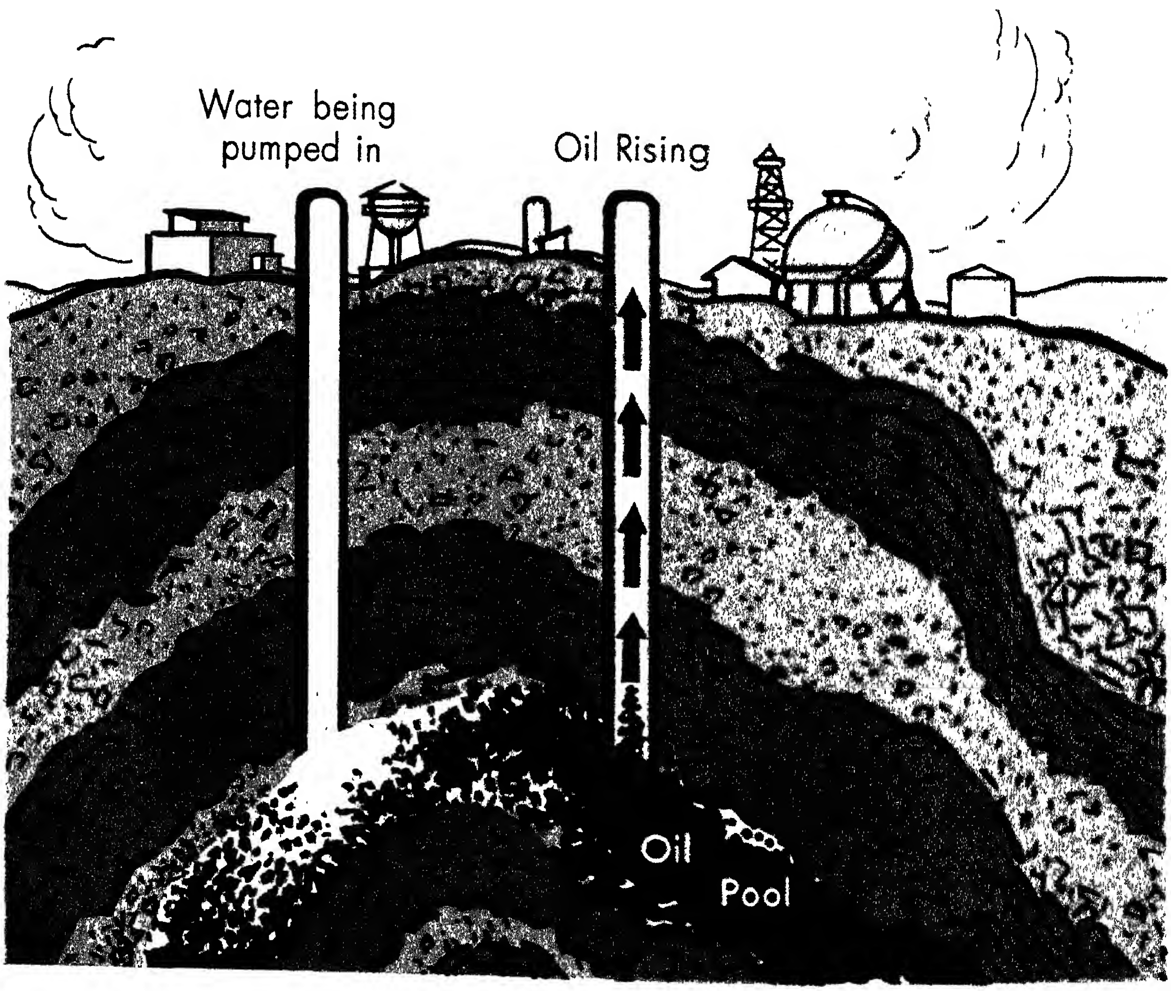
Getting More From Our Mines and Wells

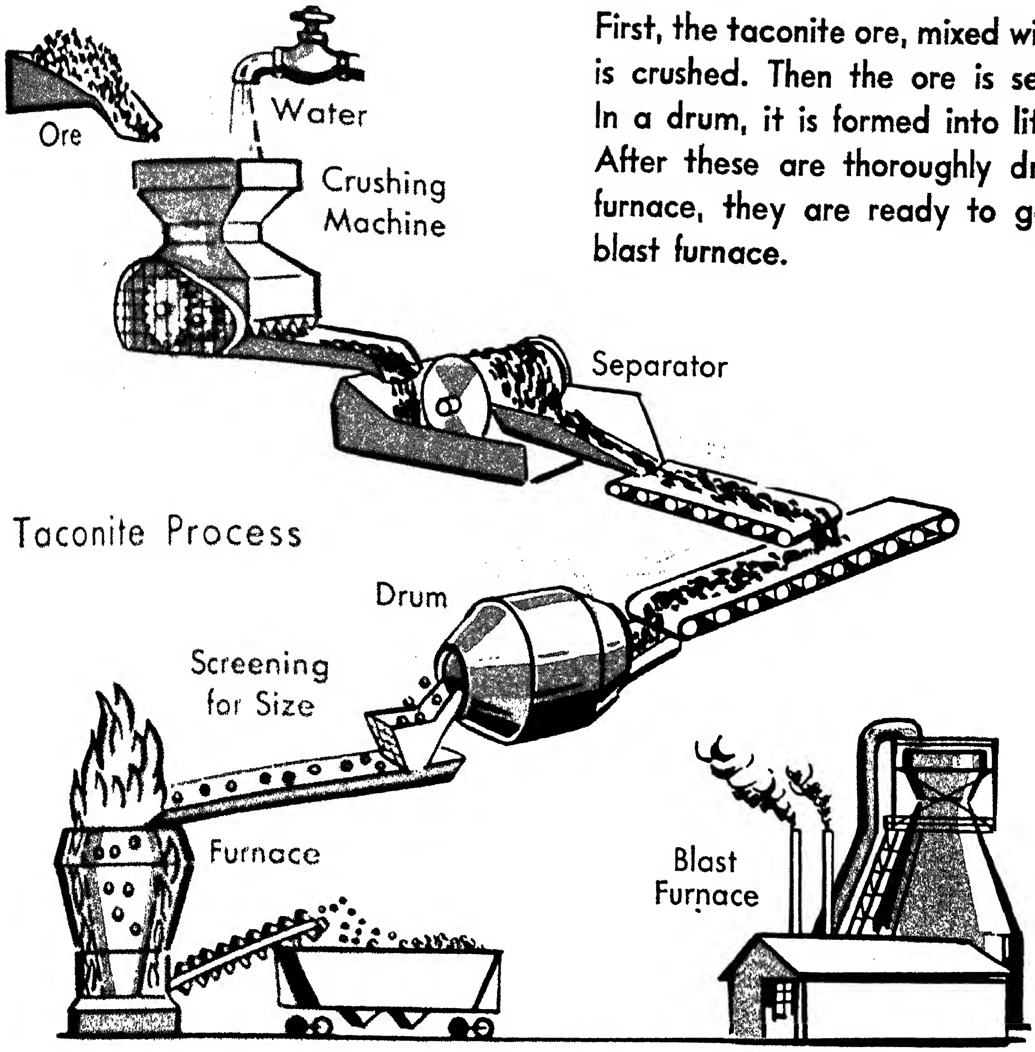
Some oil wells are considered "dry" when three-quarters of the oil in them is still there. Coal mines are sometimes left with a great deal of coal still in them. With the methods of mining we now use, it would cost too much to take out the rest of the oil or the coal.

In the drawing you see one method of removing a greater amount of oil from a single well. In this case the well has run "dry" since the oil around it has been removed. But there is still an oil pool farther out from the well. In this method, water is pumped into the oil pool through another hole. You know that oil floats on water. The water pushes the oil toward the well where it can be pumped out.

Scientists use special maps to help them locate ores. These maps show the types of rock formations beneath the earth's surface. Most ores are found only where there is some particular kind of rock formation.

But in 1950, geological maps had been made for about only one-seventh of the United States. Much mapping remains to be done, and then new mineral deposits will be discovered.



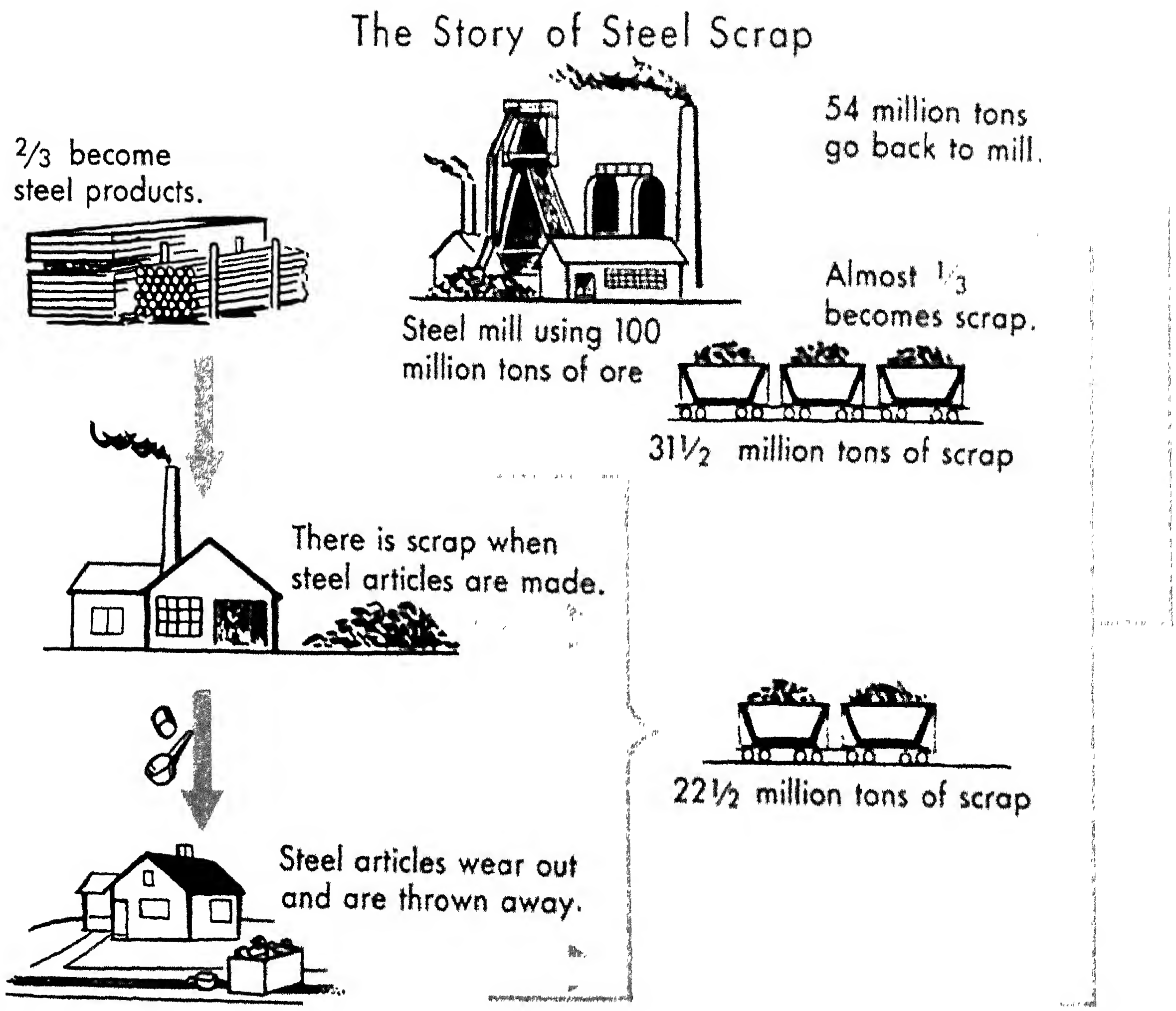


First, the taconite ore, mixed with water, is crushed. Then the ore is separated. In a drum, it is formed into little balls. After these are thoroughly dried in a furnace, they are ready to go to the blast furnace.

Using Low-Grade Ores

Another method of making better use of our supply of earth materials is to mine low-grade ores. These are ores that do not contain as much metal as the ores that have been mined in the past. Such ores are called low-grade. To use low-grade ores, the chemists must find better methods of removing metals from ores.

In 1900, the copper ore most commonly used in the United States contained about five pounds of copper for every hundred pounds of ore. Today, we mine copper ore containing less than one pound of copper for every hundred pounds of ore. The richest iron ore is more than half iron. But taconite, a low-grade iron ore, is only about one-third iron. Taconite can be used today because scientists have found a better way to get the iron out of it. Many scientists are working on the problem of getting metals from the low-grade ores.



Reducing Waste and Collecting Scrap

Most metal waste occurs in certain factories where metals are punched or pressed into a desired shape. In the process, some metal is left over. It is called scrap metal. It is saved, melted, and used again. Scrap, or waste, iron is particularly useful in making steel.

Worn-out and discarded things made of metal, such as old automobile parts, are also called scrap metal. In most communities, there are persons who buy scrap iron and sell it to steel companies.

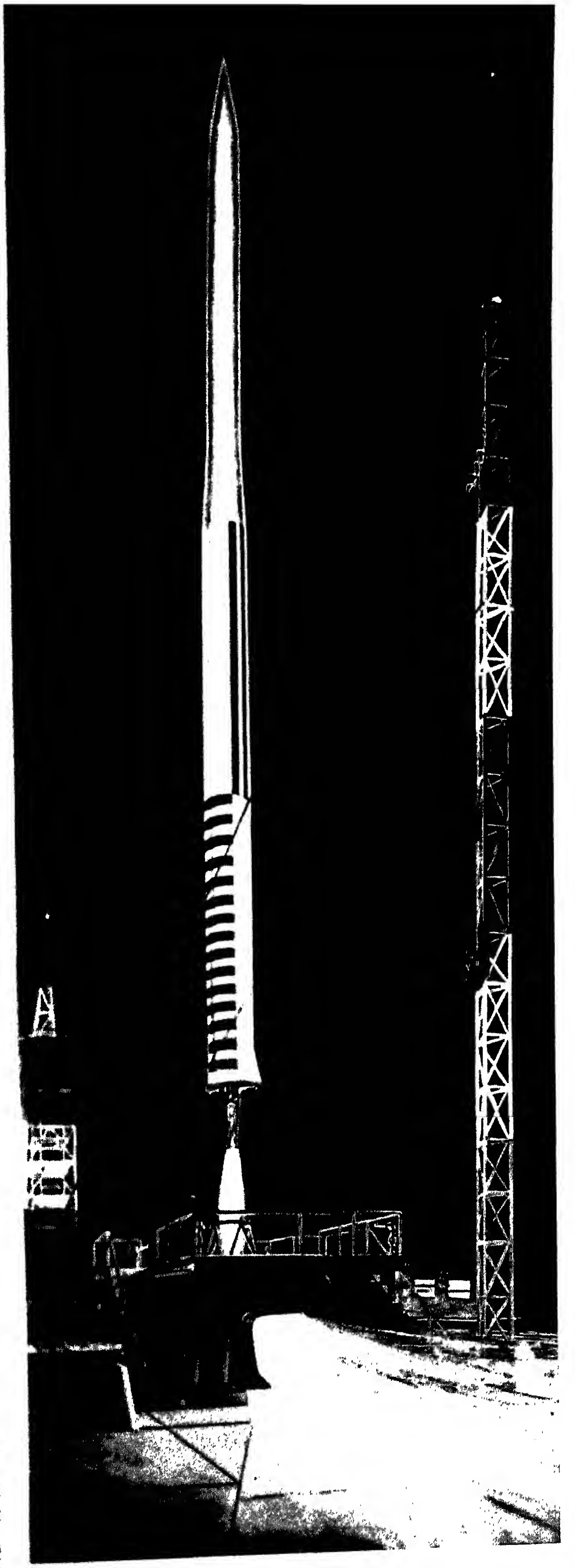
In recent years, scrap copper has furnished more than half of the copper supply in the United States. Scrap lead has furnished almost four-fifths of the supply of lead.

Thus, scrap metals around your house will probably be used again. Your old copper pot may some day furnish the wire in someone else's house. The lead in your father's old automobile battery may some day be part of a new battery.

Using New Substances

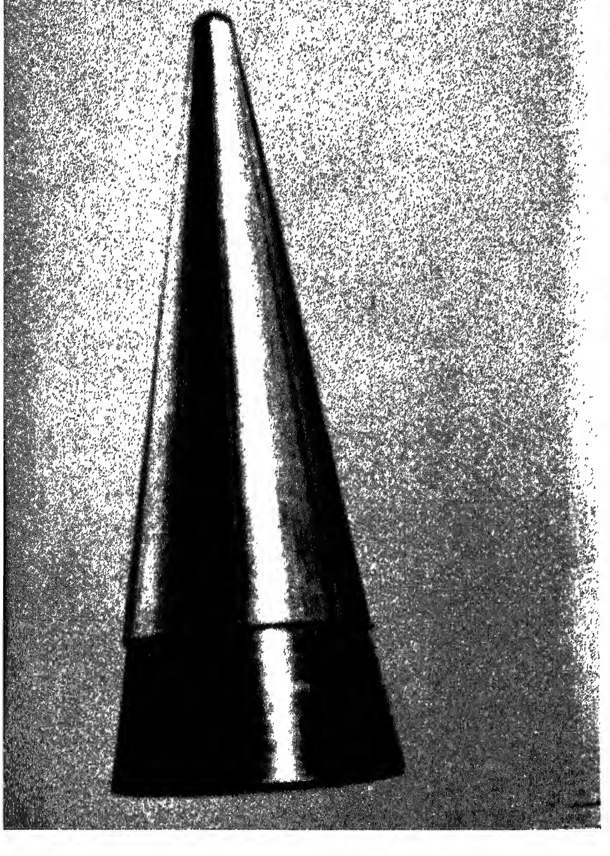
As our supplies of certain materials run low, scientists look for new ones to use instead. Chemists have found ways to make both oil and gas from coal. Since coal is more plentiful than oil, this process may have to be used in the future.

Metals called zirconium and titanium may someday replace aluminum. Both of these metals are light and strong. And they are plentiful.

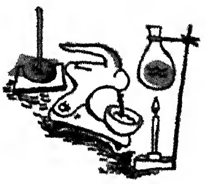


Titanium and other new materials are used in the manufacture of rockets and missiles. *Below:* The titanium nose cone of the rocket in the picture on the right.

The Martin Co.



Things to Do



1. Find out the prices for scrap in your community. Maybe you and your classmates can start a scrap-metal drive to earn money for a class project.

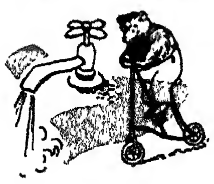
2. Keep a record of all the metal you use in one day. How many different kinds do you use?

3. Visit a spot where a new building is being constructed. Make a list of materials from the earth that are used.

4. If you can find some coke, examine a piece. How is it different from coal? Find out how it is made from coal.

5. Asbestos is a material found in the earth. It looks somewhat like fibers of wool. It can be ground up and pressed into sheets. One of the properties of asbestos is that it will not burn. Find a small piece of asbestos. Try to burn it in a candle flame. Pull off pieces of it and try to burn them. Where are some places that asbestos is used?

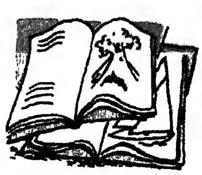
Things to Talk About



1. What materials from the earth do you use that come from outside the United States?

2. Why should everybody be concerned about conserving metals and fuels?

Things to Read About



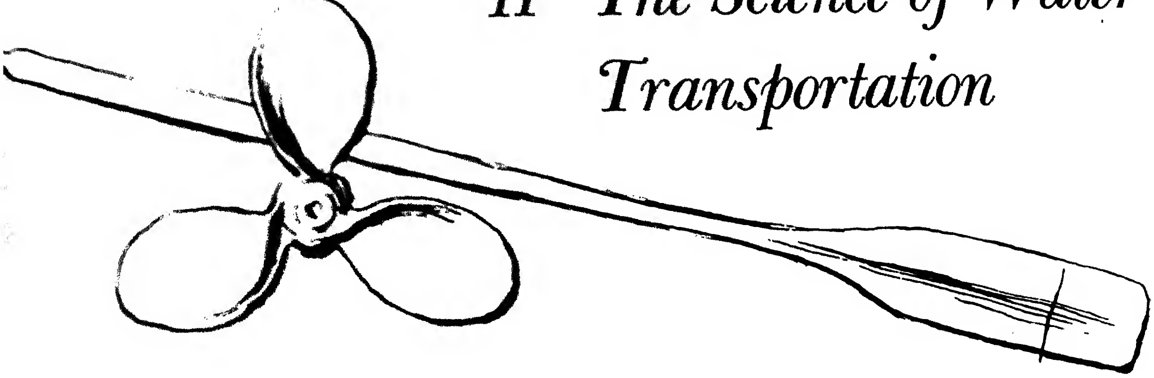
1. Find out how steel is made from pig iron and scrap. Perhaps someone in your class can report on how steel is made.

2. Look up *taconite* in an encyclopedia. Where is it found? How is the process for getting iron from it different from the process used for richer iron ores?

Asbestos

Johns-Manville

11 The Science of Water Transportation



About "*The Science of Water Transportation*"

All boats—whether they were built a thousand years ago or yesterday—must float. Early man knew that certain things, like logs and twigs, float. He knew that others, like rocks, sink. But he didn't know why.

At first, you might think it easy to guess whether an object will float or not. A rock sinks. Wood floats. A piece of iron sinks. But a rowboat is often made of wood, yet a rowboat can sink. Ships are made of iron, yet they float. Perhaps it isn't as easy as you think to guess whether an object will sink or float.

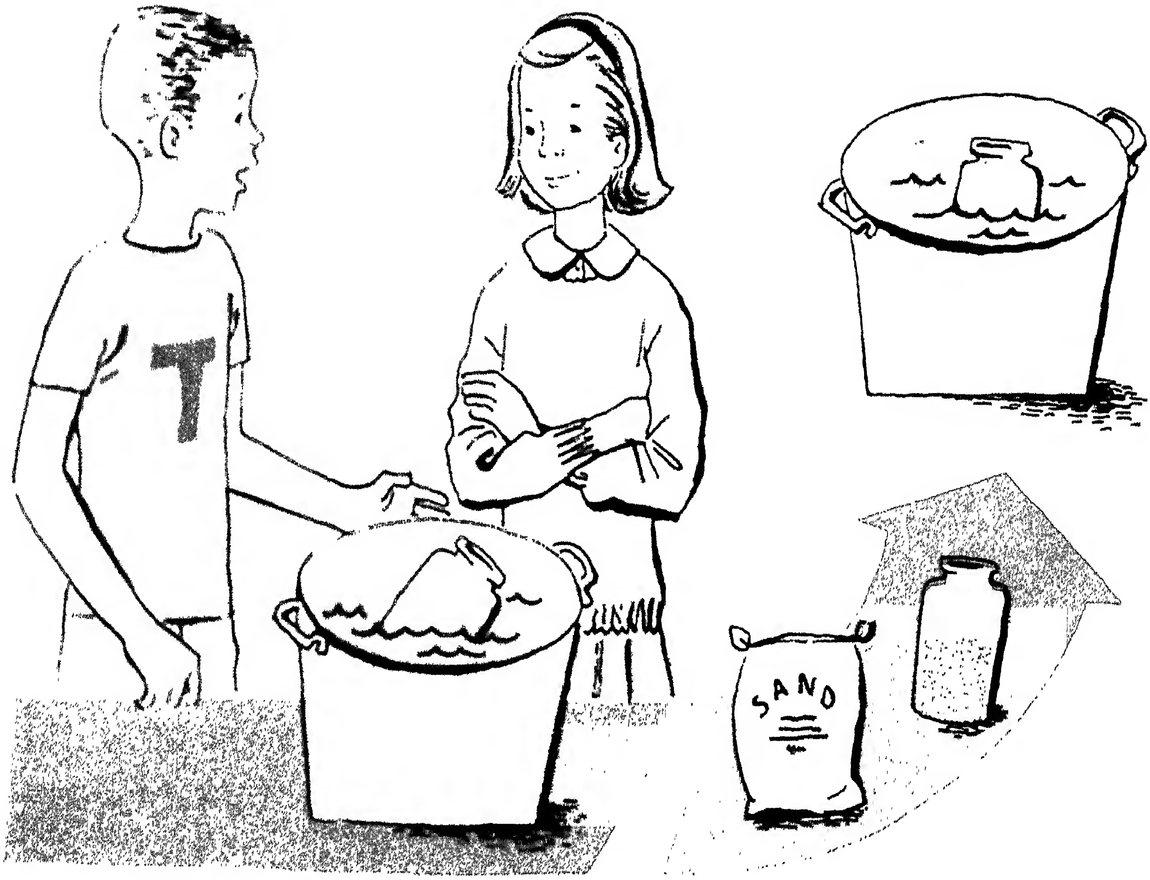
In this unit you will find out what makes an object float. You will learn about different kinds of boats: rowboats, canoes, tankers, ocean liners, and submarines. You will find answers to the following questions:

What makes a ship move?

How are ships steered?

How do you float and swim in water?

What makes a submarine dive and come to the surface?



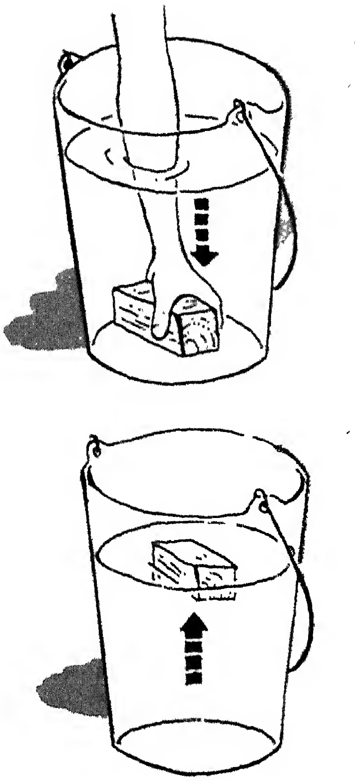
WHY DO BOATS FLOAT?

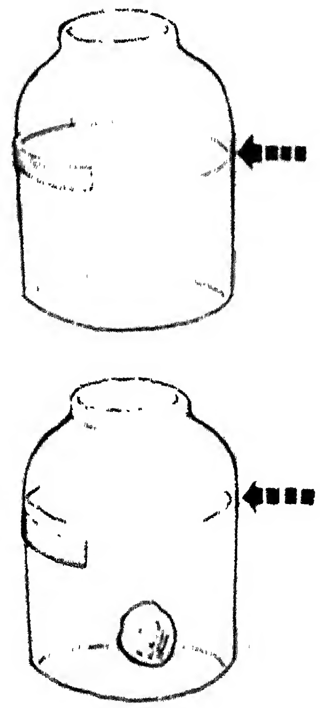
Float an open glass jar in a bucket of water. Slowly pour sand into the jar. Notice how the jar floats a little lower in the water as you add the sand. You can probably add quite a bit of sand before the jar sinks. But sooner or later the jar will sink. Why?

Perhaps your answer is, "Because it became too heavy to float." But an aircraft carrier is heavier than your jar of sand, and *it* floats. Weight alone doesn't make an object sink.

Water pushes up on any object, even if the object sinks. You know that a pebble doesn't drop as fast through water as it does through air. That is because water pushes up against it with a greater force than air does. But gravity pulls down on the pebble with a force greater than the force with which the water pushes up on it. So the pebble sinks.

Now try this. Hold a piece of wood down in a bucket of water. Hold it near





the bottom. Then let go of it. What makes it rise? The water pushes it up with a greater force than the force with which gravity pulls it down.

If the downward force of gravity is greater than the upward force of water, an object sinks. If the upward force of water is greater than the downward force of gravity, an object rises in water. If the two forces are equal, an object floats.

Float a small wooden board in the bucket. Press down on the board with your fingers. You will feel the force of the water pushing up against the board. Lift the board out of water. You will feel the force of gravity pulling down on it.

Measuring the Upward Force of Water

You know how to measure the downward force of gravity on any object. Simply weigh the object. If you weigh ninety pounds, this means that gravity pulls you downward with a force of ninety pounds.

You can measure the upward force of water by weighing water, too. Let's see how this is done.

Put some water in a jar. Make a mark on the outside of the jar at the level of the water. You can use tape for the marker, as in the drawing.

Now put a rock in the jar. What happens to the level of the water? The rock pushes some of the water away, and the level of the water rises. We say the water is **displaced.** In other words, the rock takes the place of some of the water.

Water is displaced whenever you put something into it. Larger objects displace more water than smaller ones, naturally. Try putting different objects of different sizes into your jar. See how much each makes the water level rise.

There is another way we can measure the water an object displaces. We can fill a large measuring cup with water and put a small dish or glass under the lip. Then, when we place an object into the water, the water displaced by the object is caught in the dish or glass. By weighing the water in this dish, we can tell the exact upward force of water on the object.

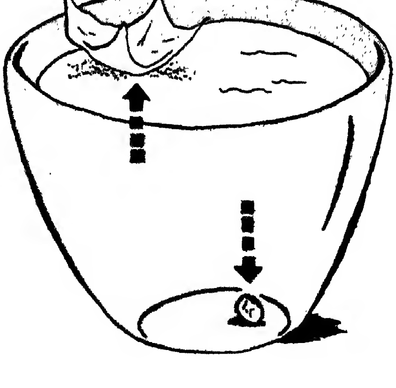
You now know how to measure the two things that determine whether or not an object floats: gravity and the upward force of the water. You measure the force of gravity on an object by weighing the object. You measure the upward force of water by weighing the displaced water.

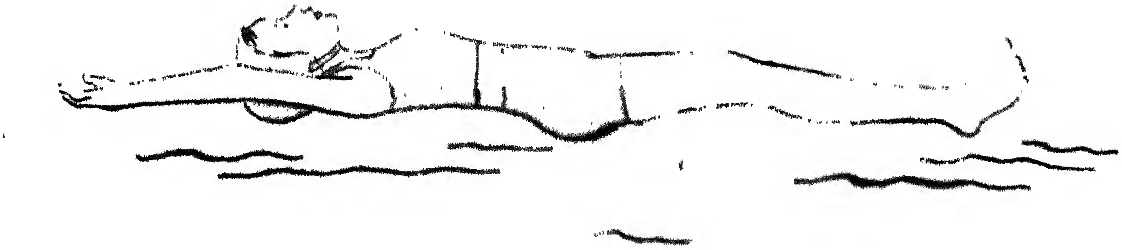
Making an Object Displace More Water

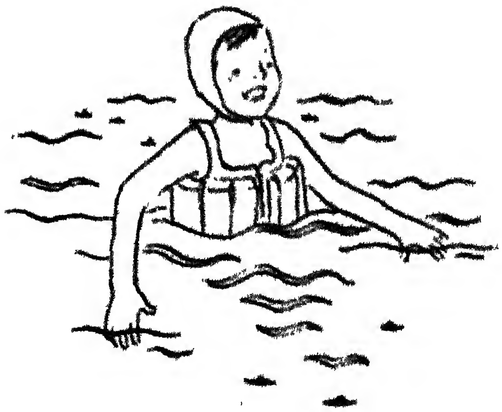
Take two pieces of metal foil exactly the same size. Turn up the sides of one piece to make a boat. Float it on the water.

Take the other piece and form it into a tight ball. You may have to hammer it to make the ball as small as possible. Now try to float the ball. If you hammer the foil hard enough, it will sink—even though it weighs exactly as much as the piece of flat foil. The foil in the shape of a ball doesn't displace enough water to make it float.

Often an object can be floated by changing its shape. If the changed shape of the object displaces an amount of water equal to its weight, the object will float. What would you do with a newspaper to make it float? To make it sink? What other objects can you compare in the same way?







Swimming

When you go swimming, you become a floating object yourself. Your body displaces enough water to keep you at the surface. In fact, if you have done much underwater swimming, you know that it is sometimes hard to stay beneath the surface. Your body is forced up by the water.

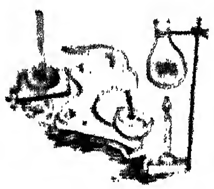
Have you ever swum by holding onto an old automobile inner tube? In some parts of the world, boys and girls use an animal skin that is filled with air. In still other places, the children have fun floating on large vases and pots!

Have you ever used a life jacket? Some life jackets are filled with a cork-like material that weighs very little for its size. A life jacket helps you keep your head above the surface.

Anyone traveling in a small boat in water over his head should wear a life jacket. In case of a sudden storm, or in case the boat suddenly tips, you are safer in a life jacket. Grownups as well as children should wear them when they go boating.

If you should ever be on a boat that overturns and you don't have a life jacket, hold on to any nearby floating object. Many wooden and metal boats are hard to sink. If you overturn in such a boat, hold on to the overturned boat itself.

Things to Do

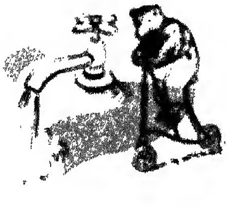


1. Plan an experiment to find out the effect of an object's shape on how fast it moves through the water. Do pointed objects move faster than round ones? Do wide objects move faster than thin ones?

2. Plan an experiment to find out which floats better, wood that has been soaked in water or dry wood.

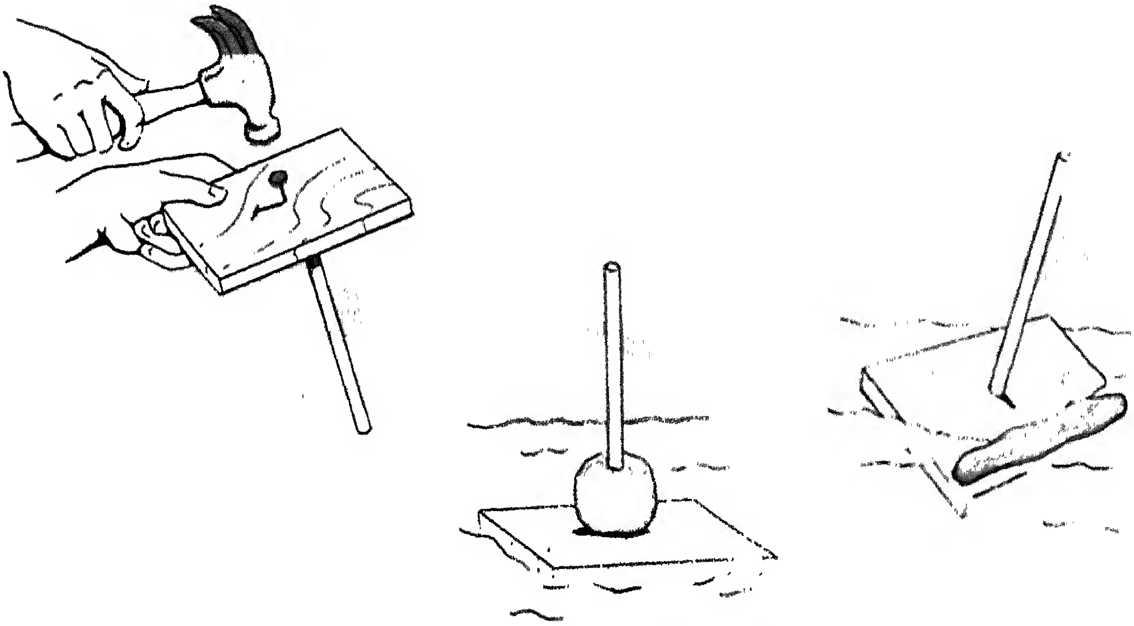
3. Draw a large poster showing different types of boats through the ages. Start with a floating log and go right up to today's ocean liners. Look up *ships* in an encyclopedia for help.

Things to Talk About



1. Have some of your classmates tell how they first learned to swim. Is there one method that seemed to work best for everybody?

2. What are the safest places for swimming in your neighborhood? In which places shouldn't you swim?



BALANCING BOATS

All boats are built so that they will float. But things can happen to make them turn over or sink. The boat may leak. When this happens, you know it will sink unless someone bails out the water fast enough. Something heavy may tip the boat enough to make it turn over. When this happens, its load is dumped into the water. Sometimes when a boat tips over, it may fill with water and sink.

To be safe, boats must be properly balanced. When they are properly balanced, they do not tip over so easily. Here are some experiments you can do to see how the load in a boat affects its balance. Make a model boat to use in your experiments. Get a flat piece of wood about one-quarter of an inch thick. This will be the part that floats in the water. This is called the hull. A piece of wood 5 or 6 inches long and 3 inches wide will work very well. Your boat will need a mast. The mast is a pole that comes up from the hull. It should be about a quarter of an inch thick and 5 inches long. It should be attached to the center of the hull. You can attach it by driving a nail through the hull from the bottom.

Float your model in a large pan or tub of water. Pack a large piece of clay around the bottom of the mast. Does your model boat tip?

Now remove the clay from the mast and put it along one edge of the hull. Roll it into a rope shape, as in the picture. Does your model tip?

Now get a second piece of clay the same size as the first piece. Leave the first piece of clay along the one edge. Place the second piece in a rope shape along the opposite edge of your model. With clay at each edge of the model, does the boat tip?

Try some of your own experiments with the model. Mold the clay into different shapes and see if it makes a difference.

These comparisons show one way that boats are balanced. Loads are placed evenly all around them. If the load is evenly distributed, some ships can safely carry huge loads.

When a freighter is loaded at the dock, the workers distribute the load evenly around the ship. If they were to load one side too heavily, the ship would tip in a heavy storm.

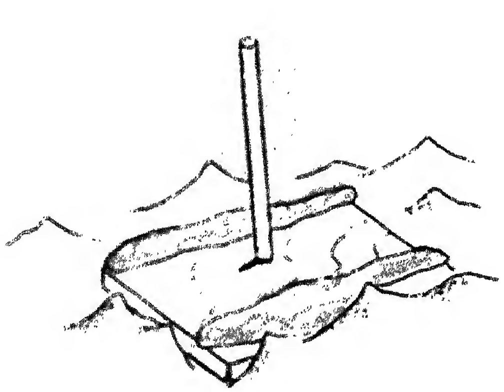
An evenly distributed load is just as important on a small boat as on a large ship. When you step into a rowboat or a canoe, always step into the center. When several people sit in a small boat, half sit on one side and half sit on the other. A first rule of boat safety anywhere is to balance the load.

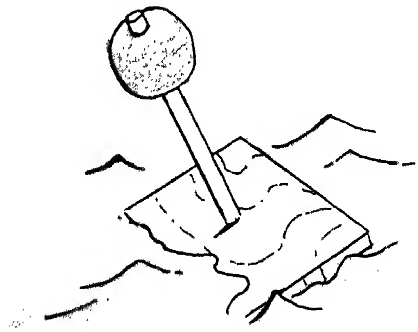
High Loads

Here is another experiment you can try with your boat model to show how the load affects the balance of the boat. Put a lump of clay around the bottom of the mast. Drop something in the water to make ripples or little waves. How much does the boat tip? You can tell this by watching how far the top of the mast moves from side to side. Now take the same lump of clay and put it at the top of the mast. Make ripples in the same way. How much does the boat tip now?

Men built boats to hold the heaviest loads down low. If too much cargo were stored high, the ship would tip more easily.

Even in a small boat, you try to keep the load low. You always sit down in a small boat. If you stand, the load gets too high, and the boat tips more easily. You saw this happen to your model when too much clay was put high on the mast. For this reason, you never change seats in a small boat.





The Shape of Ships and Boats

Boats are made in many different shapes. Some boats have round bottoms, some are flat. Some are pointed in front, others are rounded. Some have low sides, others have high ones. They are made into different shapes for two reasons, safety and speed.

Which boat do you think can tip more easily, a round-bottom boat or a flat-bottom boat? Look at the picture of each.

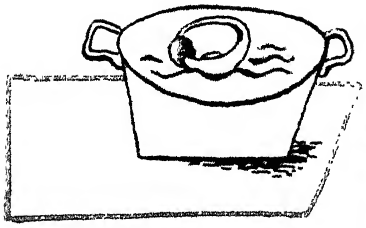
To make a comparison for yourself, get two model boats—one with a round bottom and one flat. Use some of the ways described on page 284 to compare how easily they tip.

If you can't get model boats, do this. Find a bowl or pan with a round or curved bottom. Find another one the same size with a flat or square bottom. Float them in a tub of water. Measure the distance from the edge of each to the surface of the water. This distance should be the same, or nearly so, for both bowls. If it isn't, you can't make a fair comparison.

Take a ball of clay and place it on the edge of the round-bottom bowl. If it tips and begins to fill with water, remove some of the clay. Keep testing until you get just enough clay on the edge to tip the bowl to the place where water almost runs in. Now add a little more weight to the edge of the bowl by sticking a nail into the clay. If the nail is big enough, the bowl should tip and fill with water.

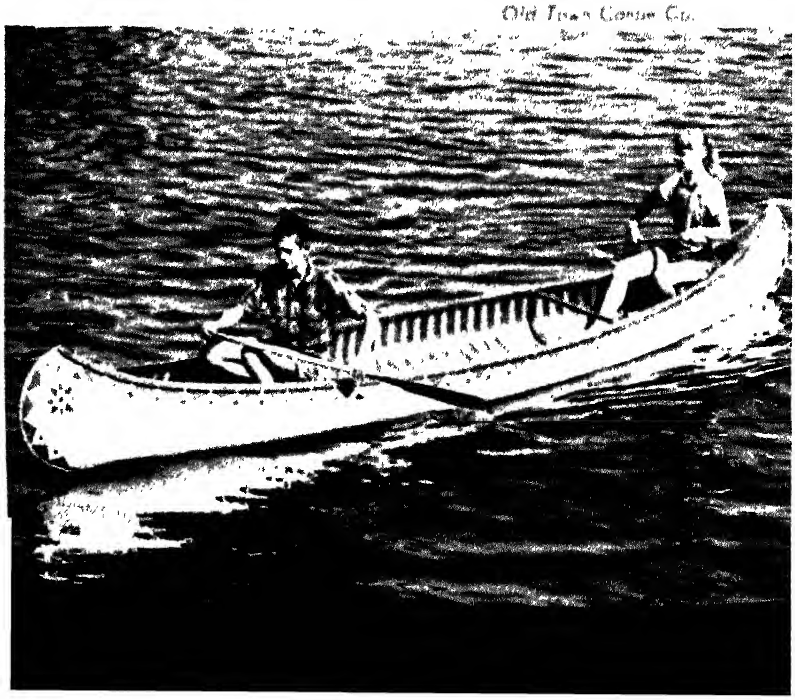
Now remove the ball of clay and nail from the first bowl and put it on the edge of the flat-bottom one. Does it tip enough to fill with water?

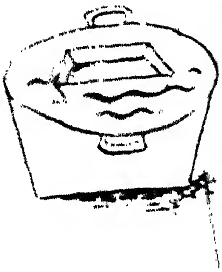
Can you explain now why it is safer for the beginner to go rowing in a flat-bottom boat?



Why should these children be wearing life jackets?

Old Town Canoe Co.

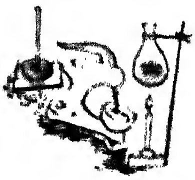




Old Town Canoe Co.

A flat-bottomed boat is harder to upset than a round-bottomed one. Even so, these children should be wearing life jackets.

Things to Do



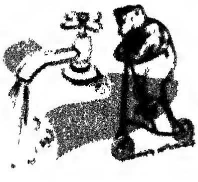
1. Get bowls or pans of different sizes and made out of different materials such as glass, aluminum, steel, and wood. How far does the water come up on the outside of each? Why is it not the same for all?

2. How much water can an empty boat hold before it will sink? Have different people in your class guess the answer. Have each one explain his guess.

Do this to find the answer. Float an empty sardine can in water. A sardine can the shape of a boat is good to use if you can find one. Pour water gently into the can until it sinks. Try it several times. How full was it when it sank?

Would this answer be the same for all kinds of boats? Would this answer be the same for a loaded boat? How could you find out?

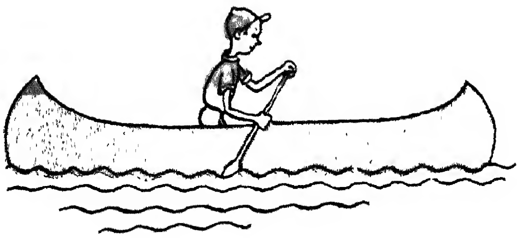
Things to Talk About



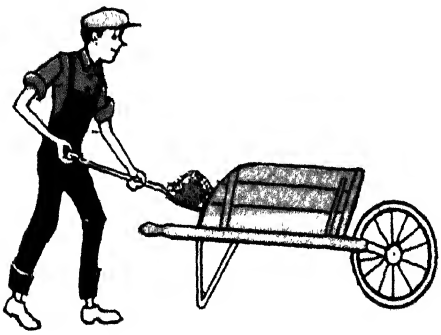
1. Which type of boat is speedier, a flat-bottom or a round-bottom?

2. Which type of boat lasts longer, aluminum, steel, or wood? Why?

POWER FOR BOATS

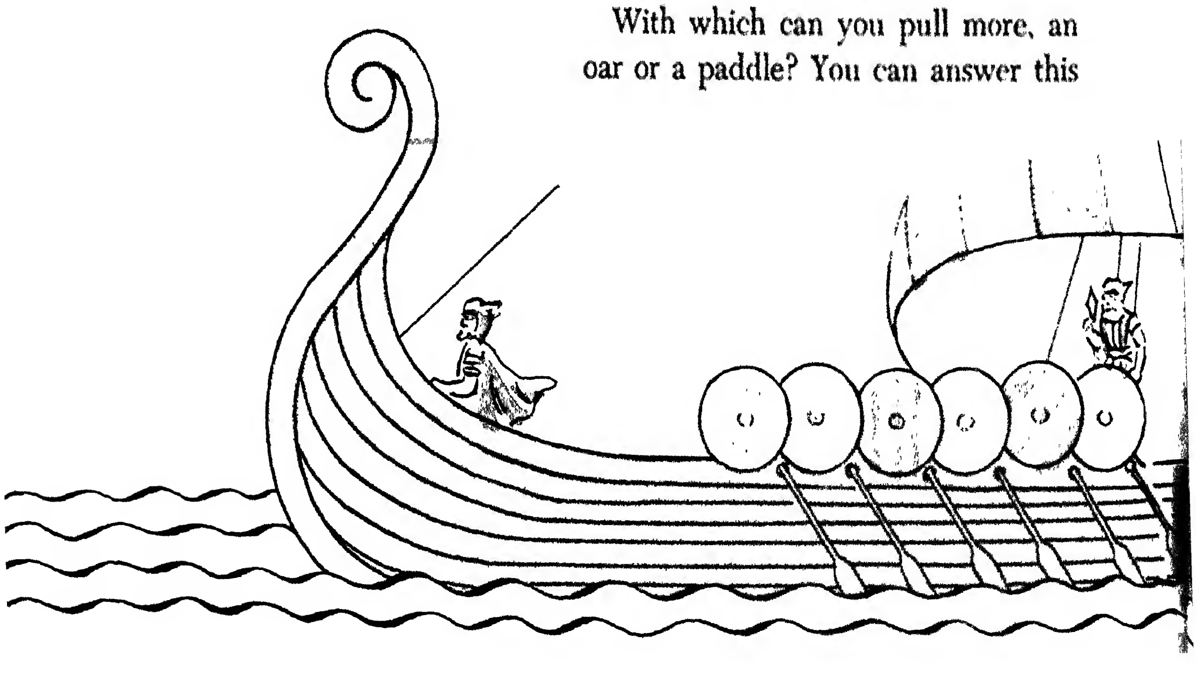


Have you ever paddled a canoe? The boy in the picture is holding the end of the paddle with one hand and pulling the middle part of the paddle with his other hand. The wide bottom pushes against the water. He is using the paddle as a **lever**. He is using it in the same way that the man in the picture is using the shovel to put the sand into the wheelbarrow. The sand is the load on the shovel. What is the load on the paddle? You can push a boat with greater force by using a paddle than by using your hands.

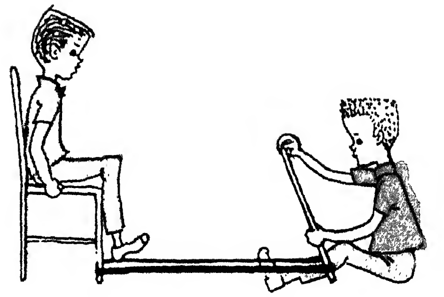


One difference between an oar and a paddle is that the oar is attached to the boat. The paddle is not attached. In the picture below, you see an early ship in which dozens of oars were used to move it through the water. About two thousand years ago many big boats were of this type. A man was needed to pull each oar.

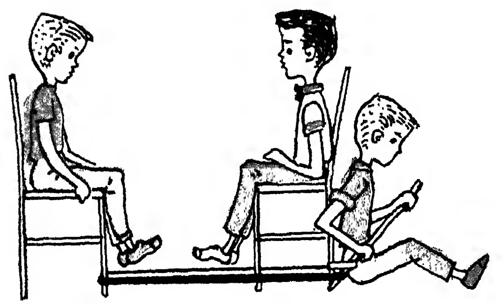
With which can you pull more, an oar or a paddle? You can answer this

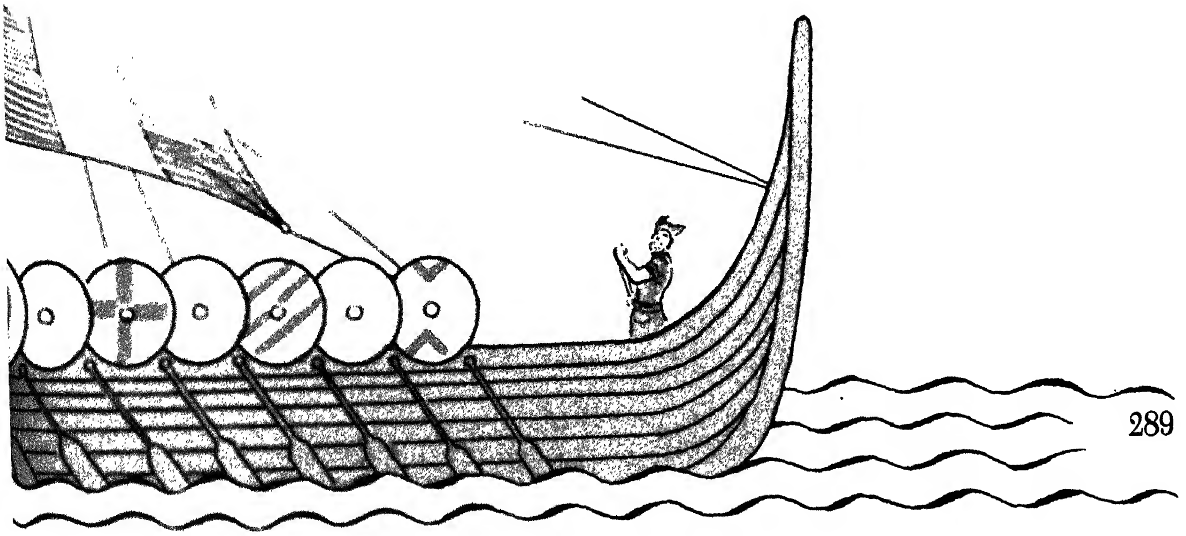


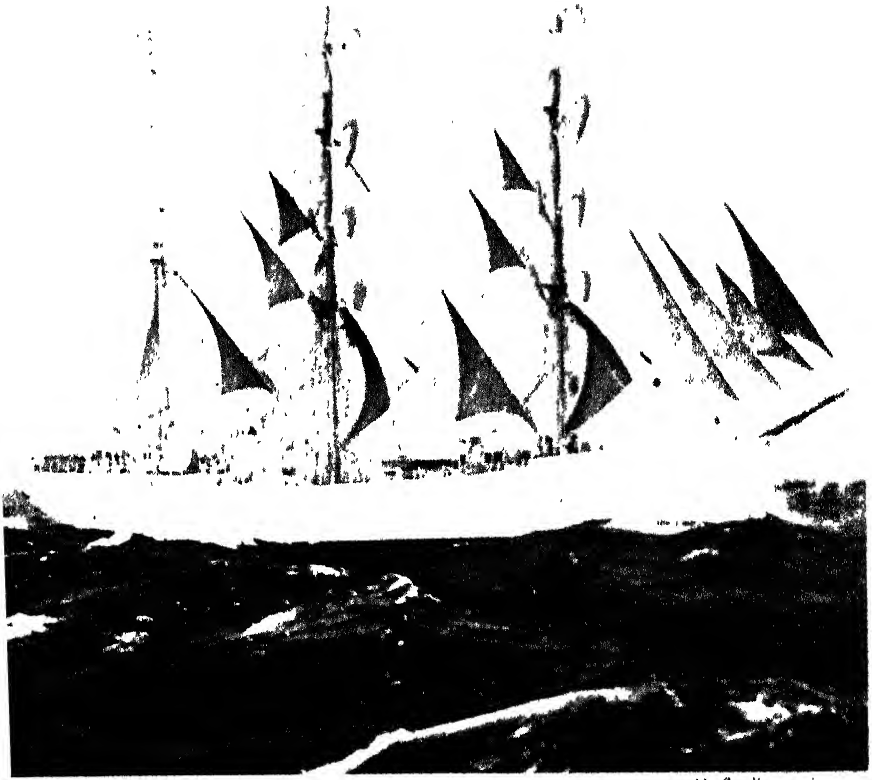
question without a boat, or water, or even regular oars or paddles. You can do it in this way. From the outer side of an old inner tube cut a band an inch wide and two feet long. It should look like a large rubber band. Loop one end of the band around the leg of a chair as in the picture. Have someone sit in the chair. Loop the other end of the band over the end of a strong broomstick. Now sit on the floor and hold the broomstick like a paddle. Move back until the rubber band and broomstick are in the position shown in the picture. Then pull as you would on a paddle and have someone measure how far you stretched the rubber band.



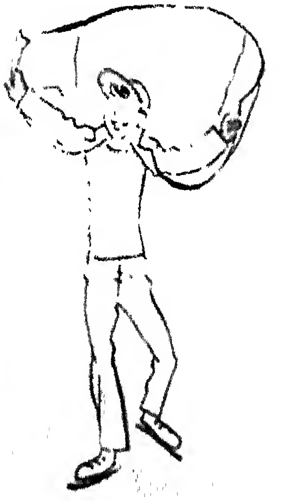
Now repeat the test by using the broomstick as an oar. It will have to be held or locked firmly as an oar would be on the side of the boat. You can now pull in one direction with both hands. As you pull, have someone measure how much the rubber band stretches. How does this compare with how much you could stretch the band with the paddle?







A United States Coast Guard training vessel. Its sails are catching the wind.



Using the Force of the Wind

People who first used any kind of boat probably noticed that the wind partly controlled the movement of their boat. When the wind was with them, they swiftly got where they were going. When it was against them, they made poor progress.

But the sail, a piece of cloth specially designed to catch the wind and use its force, was a great advance in the history of boats. Now the wind could be used to make ships go faster than ever before.

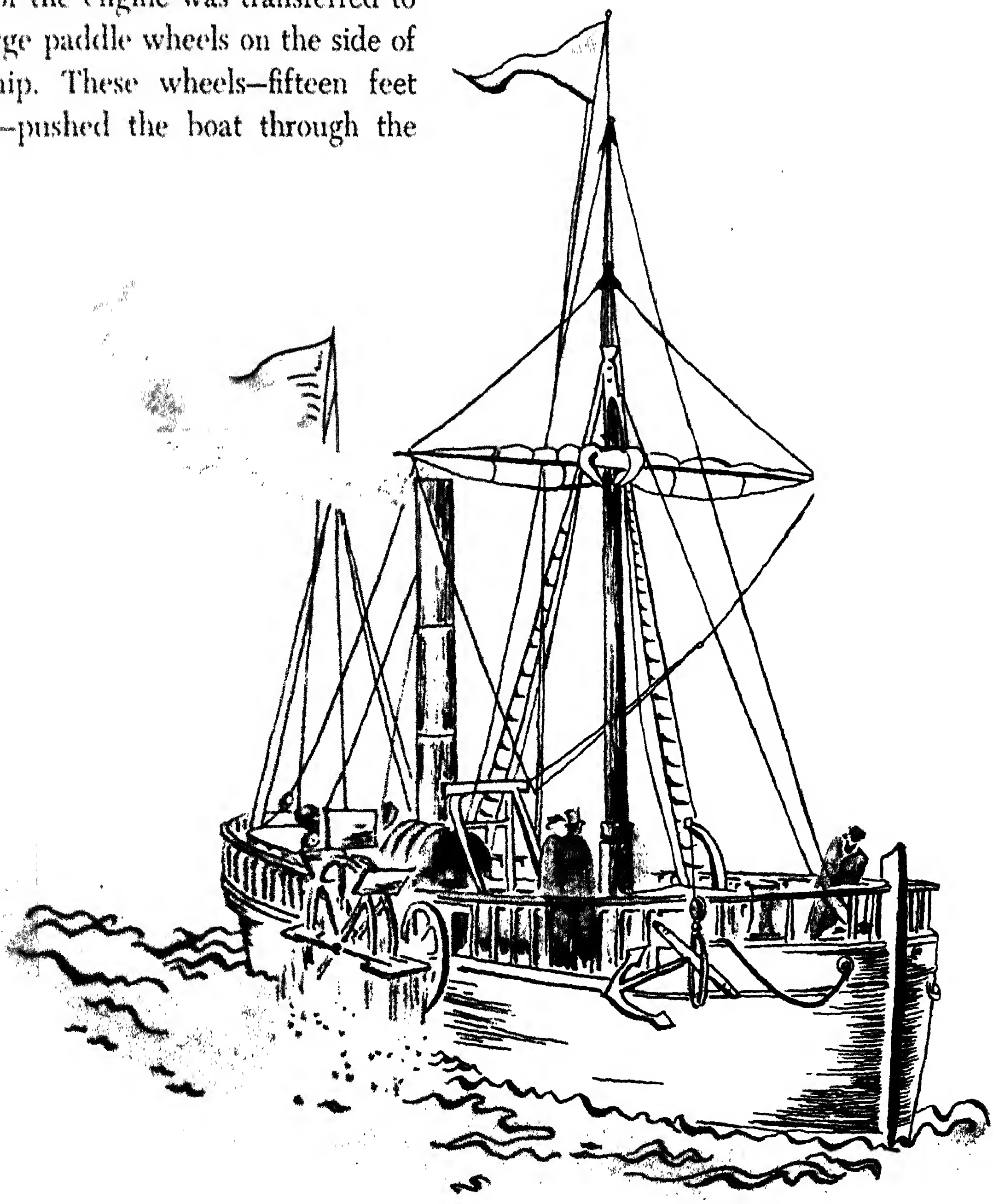
Have you ever "sailed" on skates, as the boy in the picture is doing? Instead of using so much force from the muscles of your legs, you use the force of the wind.

The great explorers of three hundred, four hundred, and five hundred years ago traveled in ships moved by the wind. These ships had huge sails that were carefully turned to catch exactly the right amount of wind.

Paddle Wheels

If there is no wind, a sailboat can only drift with the current, like a log.

The first ship that was not pushed by wind, or man-pulled oars, was Robert Fulton's "Clermont." This ship, built in 1807, used the force produced by a steam engine. You will read about steam engines later in this unit. The force of the engine was transferred to the large paddle wheels on the side of the ship. These wheels—fifteen feet across—pushed the boat through the water.



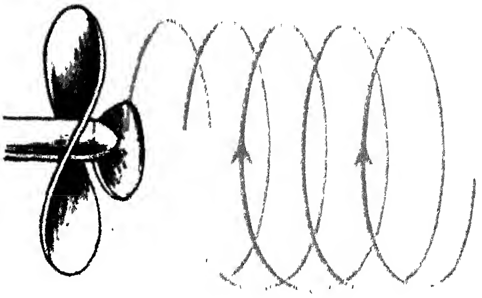
Propellers

Propellers—powered by engines—move almost all of today's big ships. You can show the action of a propeller in this way. Get a nut and bolt. Turn the bolt with one hand while holding the nut still with the other. Notice how the bolt moves through the nut.

The same type of movement happens when a screw is turned in a piece of wood. Both of these actions take place because the ridges or threads on the screw and the bolt are tilted. If they were straight up and down, there would be no forward movement. Trace the threads on a bolt to see how they run. Which way would you turn the bolt to get it to move in different directions on the nut?

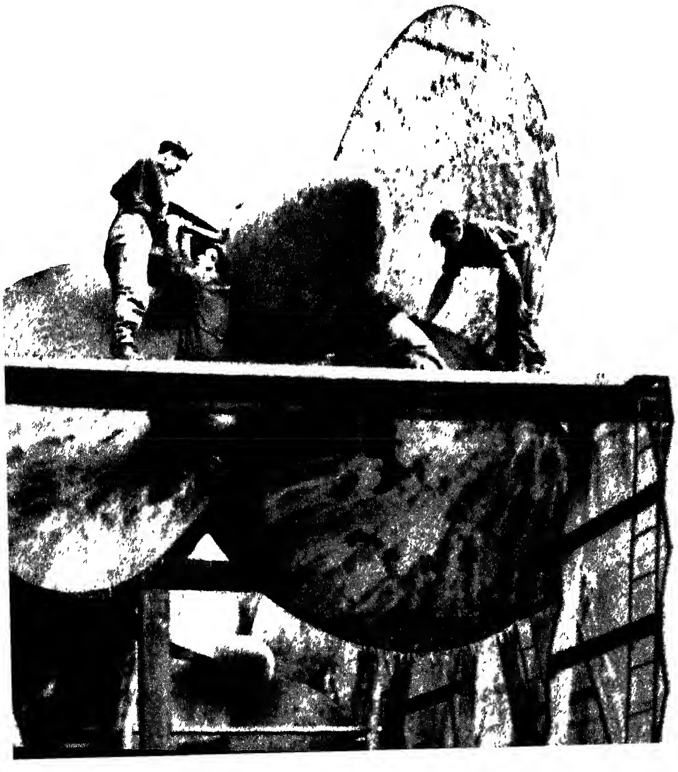
A propeller moves through the water by an action similar to a screw. The blades of the propeller are bent—like the blades of an electric fan. Notice how they form a screw-type pattern as the propeller turns. Just as a bolt is pushed or pulled through a nut as the bolt turns, a propeller is pushed or pulled through the water.

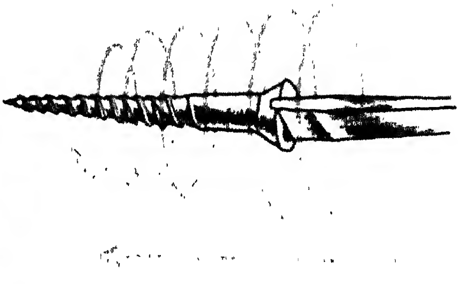
The speed of a ship is usually controlled by changing the speed of the propeller. The size of the propeller also affects a ship's speed. A large propeller has a greater force than a small propeller that is turning at the same speed.

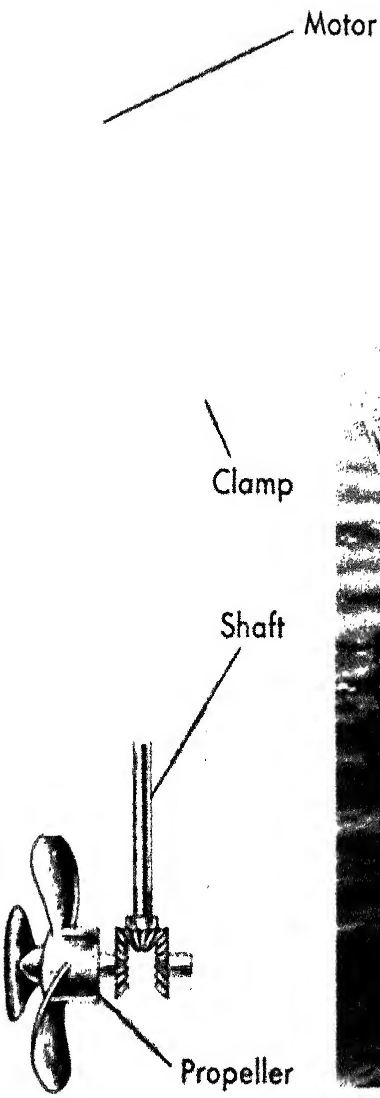


You can see how big the propeller of an ocean liner is by comparing it in size with the men working on it.

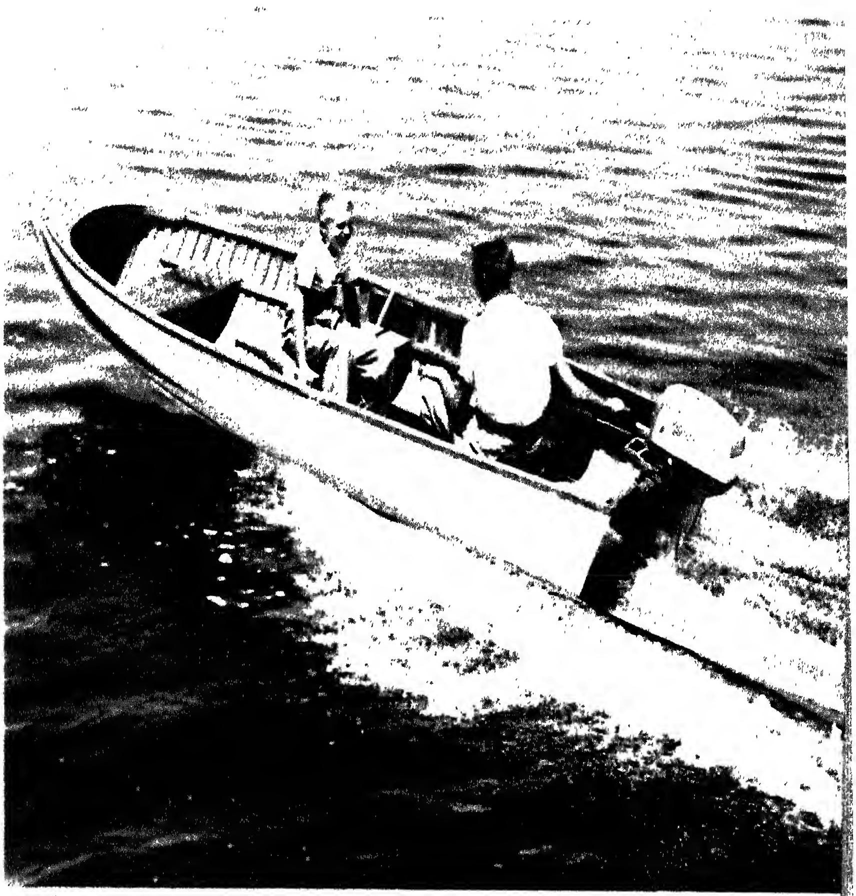
Ewing Galloway







A ride in a boat with an outboard motor



Evinrude Motors

Engines

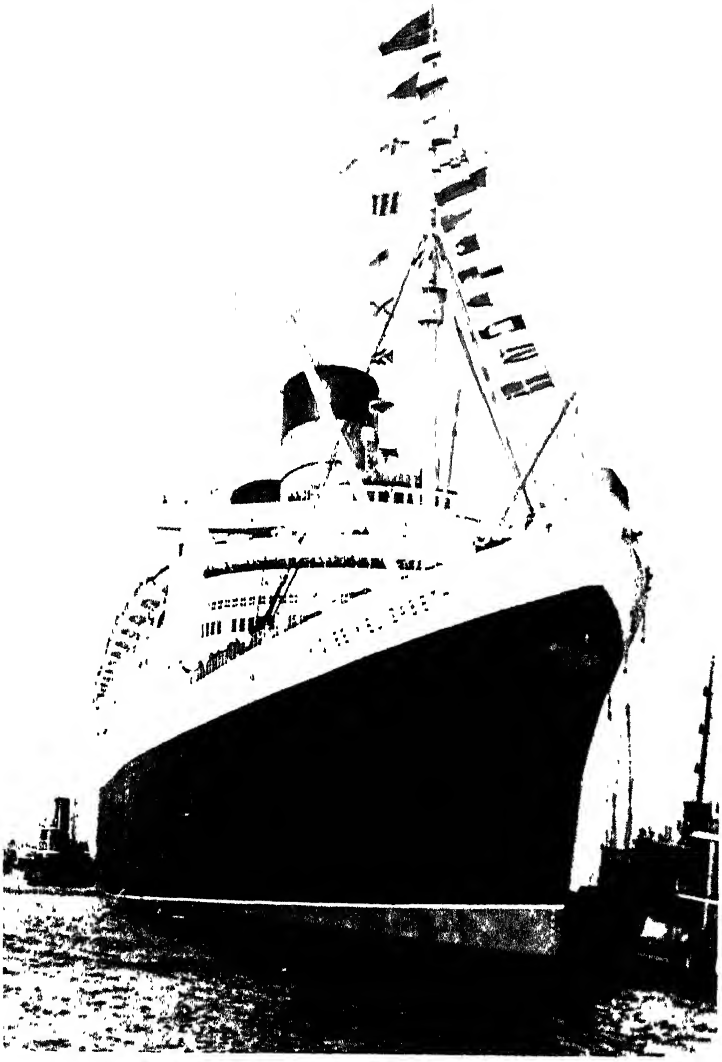
If a boat doesn't use the force of the wind or man-pulled oars, it must have an engine. The engine turns either the paddle wheel or the propeller.

Engine-driven ships don't depend on the wind. They work in any type of weather. And they make ships go faster than is possible with oars or sails.

The smallest boat engines are those attached to a boat. These engines are called outboard motors. They are attached to the back of the boat with clamps. A small propeller connected to the engine by a turning rod called the shaft, pushes the boat through the water. Such engines use gasoline as fuel.

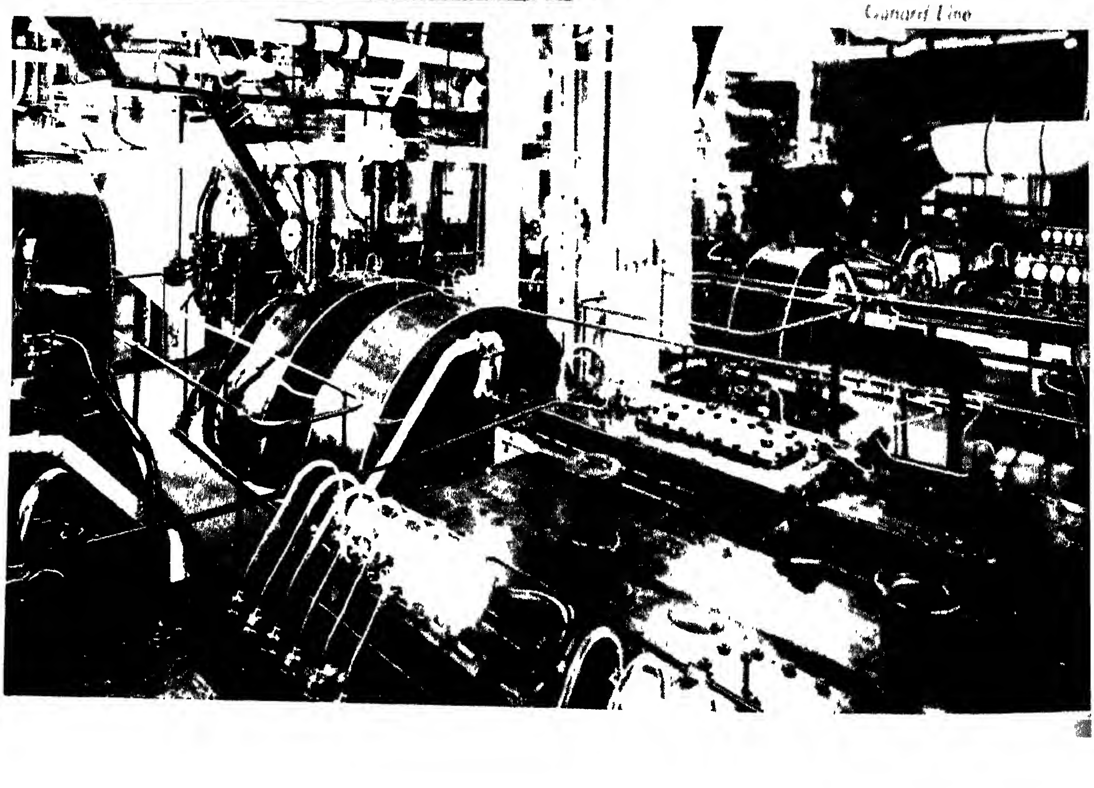
On larger ships, the engines are built in. Such engines are called inboard motors. The propeller is connected to the engine by a shaft that runs along inside the bottom of the ship.

Port of New York Authority



Left: The *Queen Elizabeth*. *Below:* The engine room of the *Queen Elizabeth*

Cunard Line



Steam Engines

Two types of engines are used on boats and ships—steam engines and gasoline or oil engines. In a steam engine, the fuel is burned outside the engine. In a gasoline or oil engine, it is burned inside the engine. In both kinds of engines, liquids are changed to gases. The gases need much more space. They push against things with a great force.

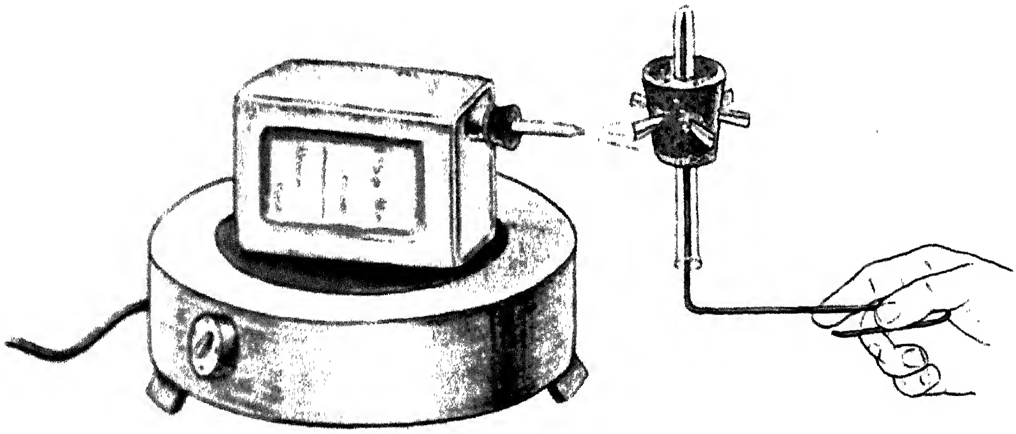
You can see this happen. Get a tin can like the one in the picture. Find a cork that will fit tightly into the opening. Put a little water into the can. Then put in the cork and heat the can. Be sure to keep your face away from the top of the can. If the cork fits tightly and there are no leaks in the can, the cork will blow off. It blows off because the water has been changed to steam. The steam pushes with greater force against the inside of the can. Since the cork is the only thing that can be moved, it is blown out.

Now make a hole through the cork big enough to stick the glass part of a medicine dropper through. Let the small end stick out. Then make the other thing you see in the picture. You will need a large cork, a test tube, six pen points, and a stiff piece of wire.

Now heat some water in the can until steam begins to come out of the tube. Let the steam hit the sides of pen points, as in the picture. The cork and the test tube will whirl around on the wire. You have made a steam turbine.

On ships, oil or coal is burned to produce steam. Big steam turbines are connected to a long steel rod. The other end of the shaft is connected to the propeller. The turbine turns the shaft and the shaft turns the propeller.

The "Queen Mary" is an example of a ship powered by steam turbines. The four sets of turbines have 257,000 blades. They have 27 separate boilers where water is heated by fuel oil to make steam. The "Queen Mary's" sister ship, the "Queen Elizabeth" is also powered by steam turbines. Both ships travel at about 40 miles an hour.



FOR PLEASURE

Below: In Venice, Italy, tourists enjoy riding the canals in gondolas. *Right:* Sailing on Great Salt Lake, Utah

Italian State Tourist Bureau

Matson Line

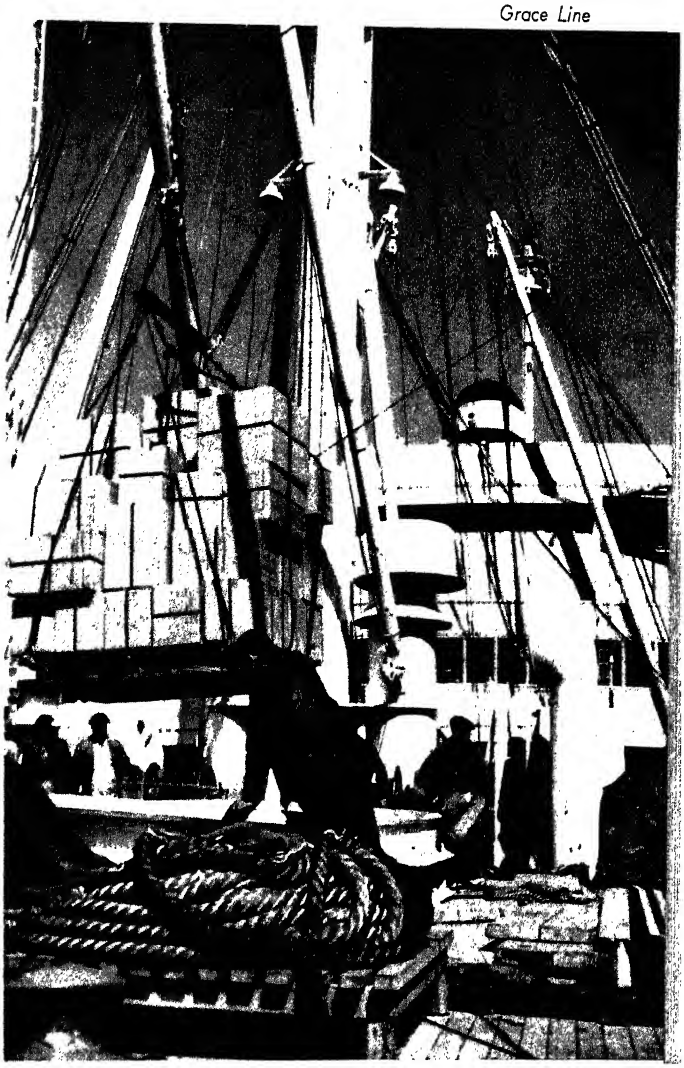
An ocean trip makes a pleasant vacation.

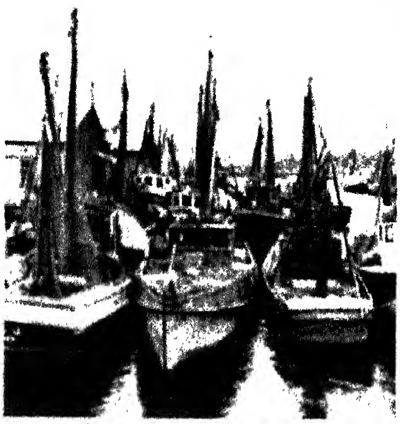
Cities Service Co.

FOR BUSINESS

Below: Freighters carry goods all over the world. *Left:* Oil is transported in special ships called tankers.

Grace Line





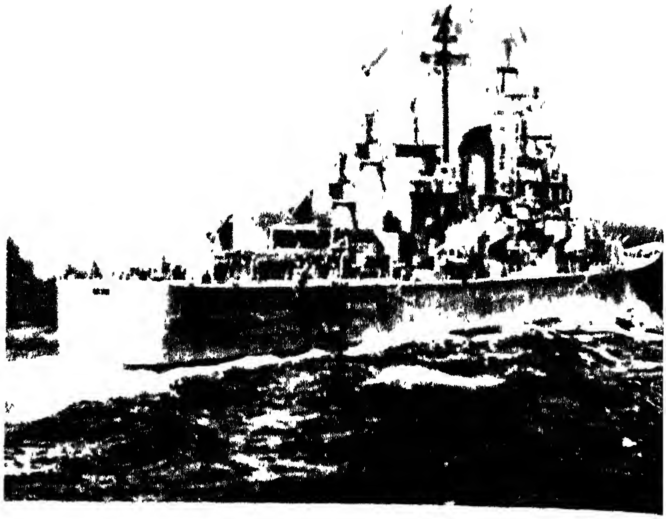
St. Augustine Chamber of Commerce

Above: Shrimp boats in Florida. **Below:** Many people take ferries to and from work.

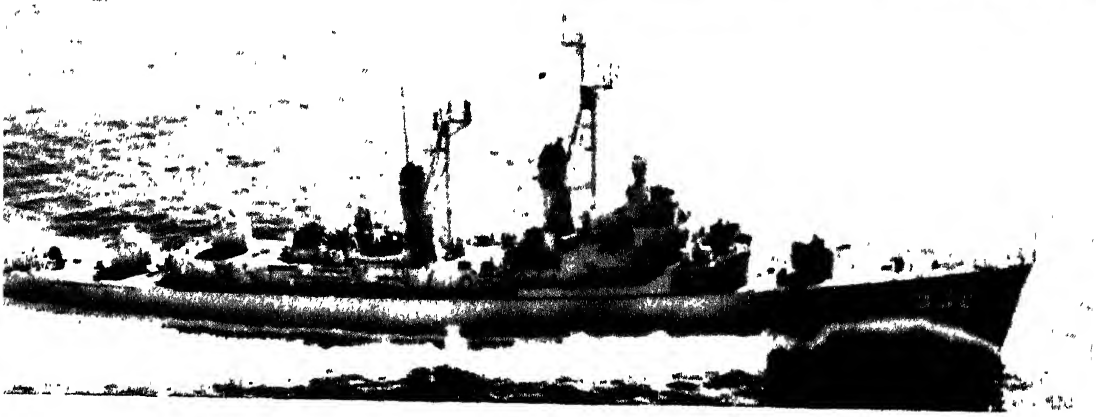
N. Y. C. Dept. of Marine and Aviation

FOR DEFENSE

Right: The cruiser *U. S. S. Boston* firing a missile. *Below:* The destroyer, *U. S. S. John Paul Jones*

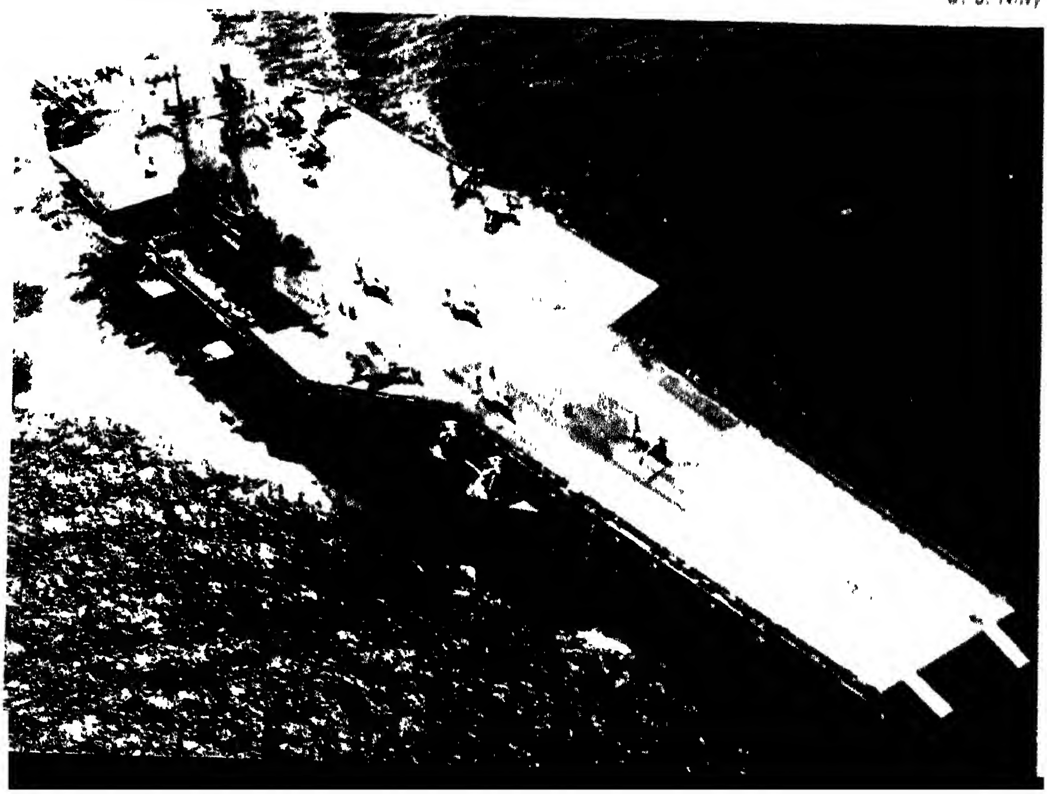


U. S. Navy



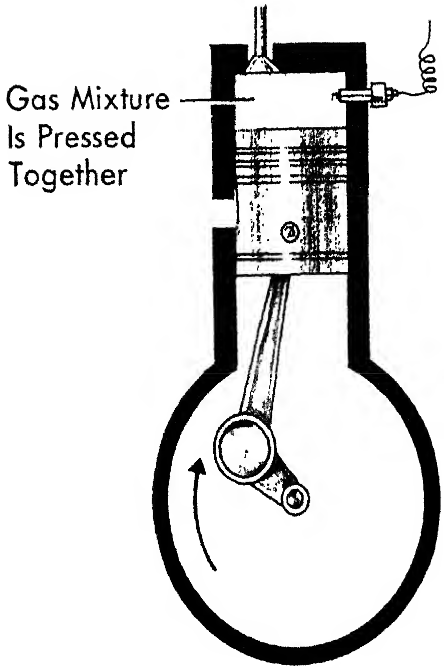
U. S. S. Saratoga, an aircraft carrier

U. S. Navy

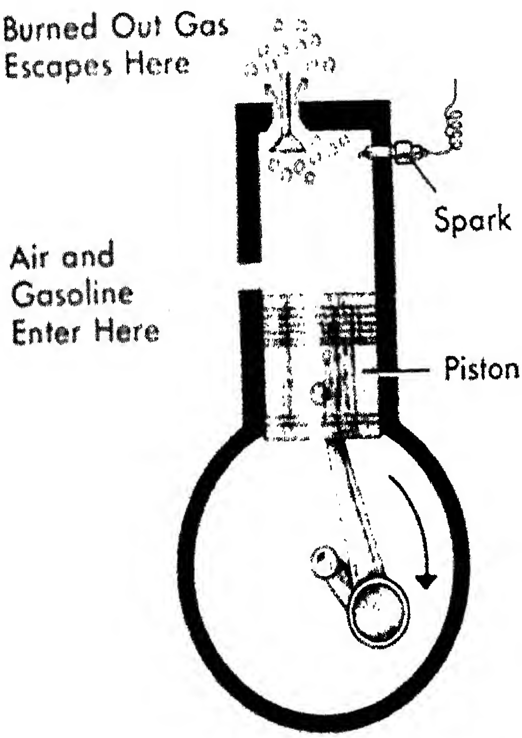


Gasoline and Diesel Engines

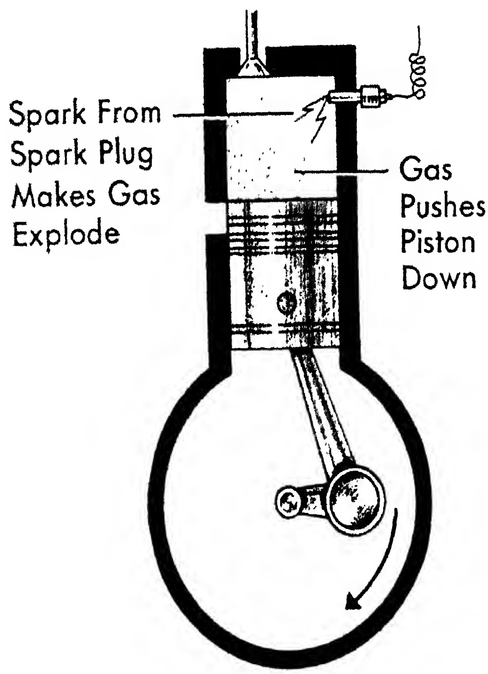
The engines of outboard motorboats and the engines on some of the largest liners burn gasoline or oil. In such engines the fuels are burned in small chambers. When gasoline or oil burns, gases are formed. These gases take up much more space than the fuel they were made from. These gases push against **pistons** that are connected to a shaft. These engines are similar to those used in automobiles.



2. Piston Moves Up



1. Piston Moves Down



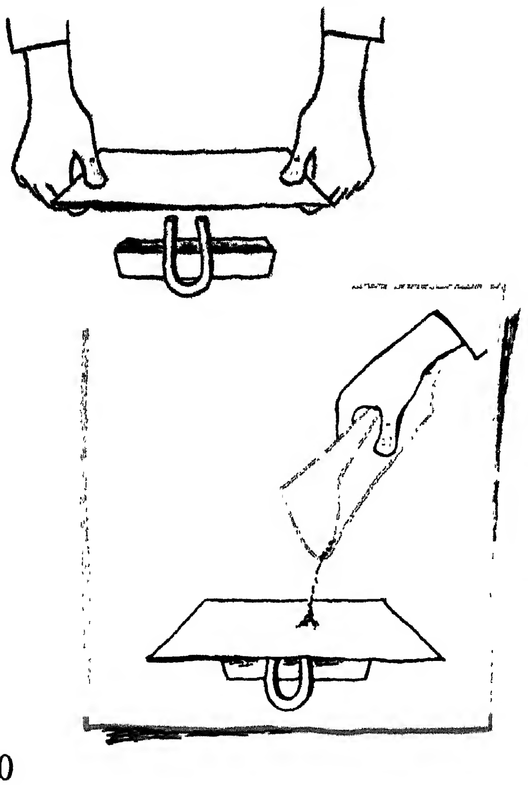
3. Piston Moves Down

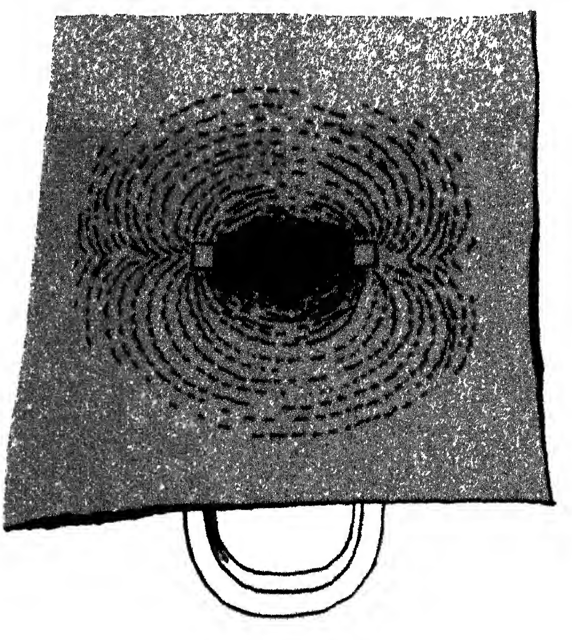
Electric Ships

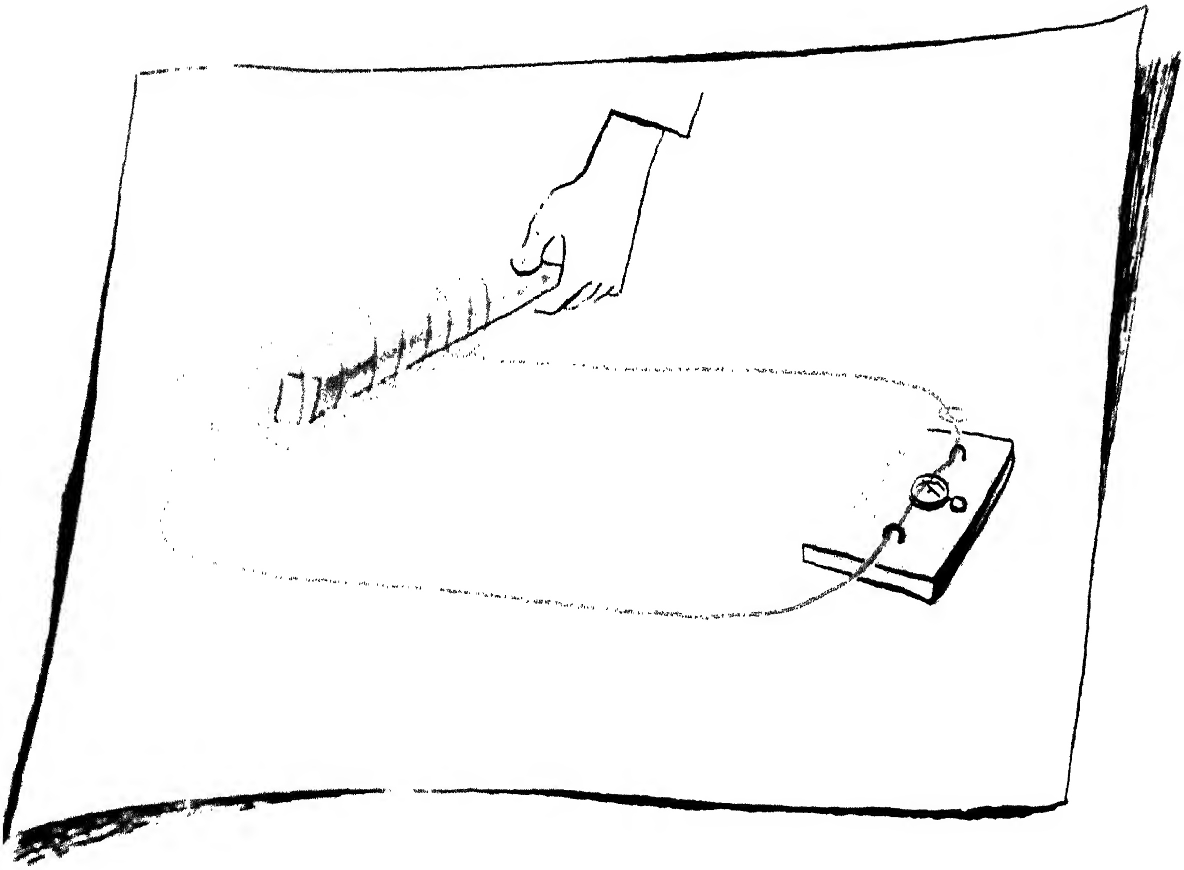
On some ships the propellers are turned by electric motors. There are a few electric ships where the motors are run by electricity from large batteries. A battery is made up of a number of electric cells. Materials inside the cells make the electricity. But electricity is also made in another way. To understand how this is done we must learn some more about magnets and electricity.

A magnet does not have to touch things made of iron or steel in order to pull on them. You have seen how a magnet pulls on tacks even when there is a cardboard in between. This is because there is a force around the poles of a magnet. You can see how this force works by doing the next activity.

Place bar magnets and a horseshoe magnet under pieces of stiff paper as you see in the picture. Sprinkle iron filings on the paper. Tap the stiff paper a little bit. The iron filings will be drawn by the magnet into a pattern of lines. These lines show where the force around the magnet is working. We call this space around the magnet its **magnetic field.** A strong magnet has a stronger magnetic field than a weak one. You know what happens when you hold a magnet near a compass. The compass needle turns because of the magnetic field around the magnet.





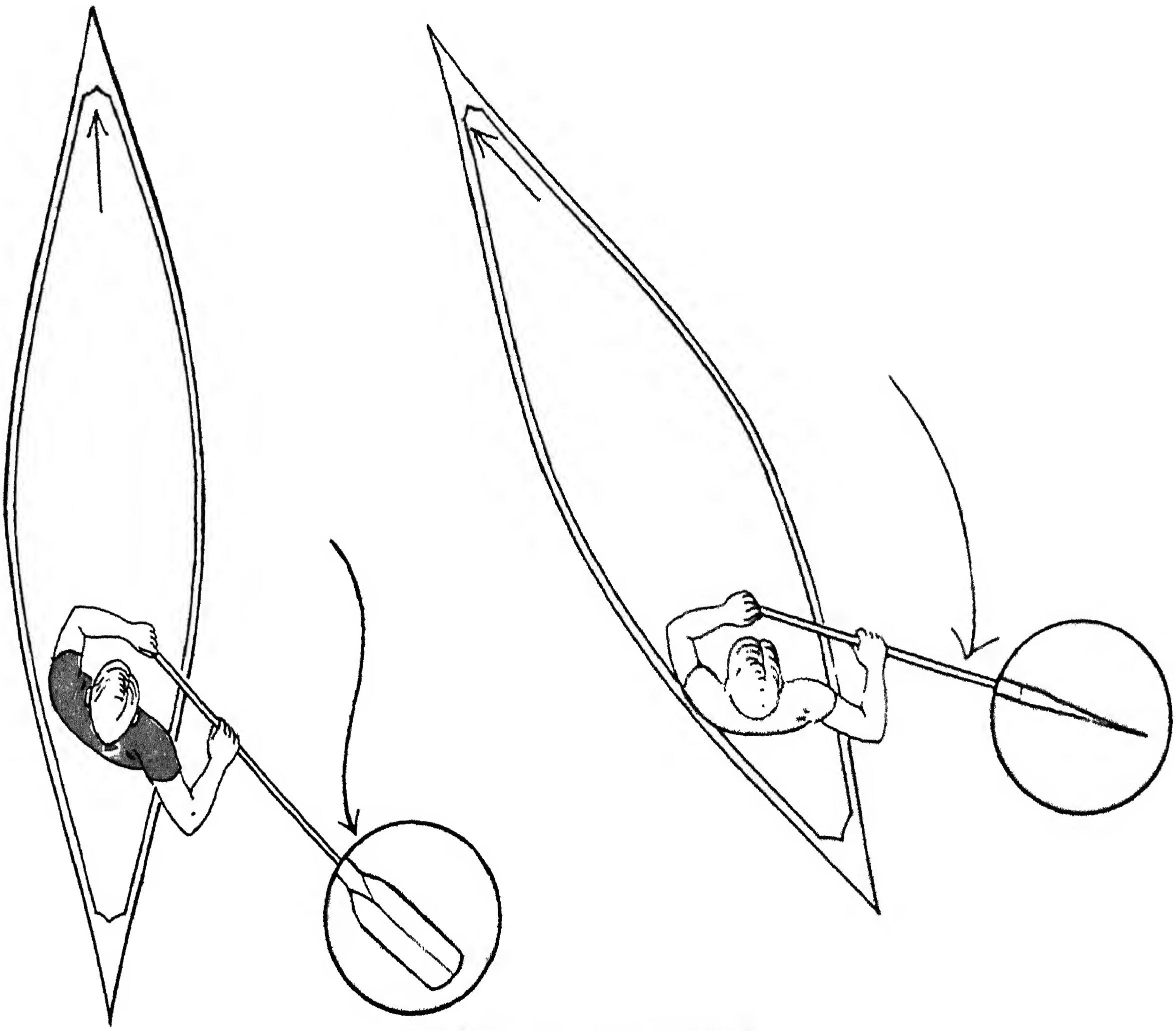


Once a scientist brought a wire carrying an electric current near a compass. The compass needle turned just as it did when the magnet was brought near it. The scientist had discovered that a current of electricity also had a magnetic field around it. Do you remember what happens when electricity goes through a coil of wire around a nail? It makes an electromagnet.

After scientists had discovered that a current of electricity could be used to make a magnet they wondered if the opposite was also true. They wondered if they could use a magnet to make electricity. After a great deal of work, a great scientist named Michael Faraday found out that this could be done.

You can make a current of electricity with a magnet. Make a coil of wire like the one in the picture. Attach the loose ends of the wire to make a loop and lay the loop over a compass. Now push a bar magnet back and forth through the coil of wire. What happens to the compass needle?

This is the way that electricity is made on most electric ships. Many coils of wire are turned rapidly through strong magnetic fields. Diesel engines or steam engines turn the coils. The electricity produced in this way runs electric motors connected to the propeller shaft.



STEERING SHIPS

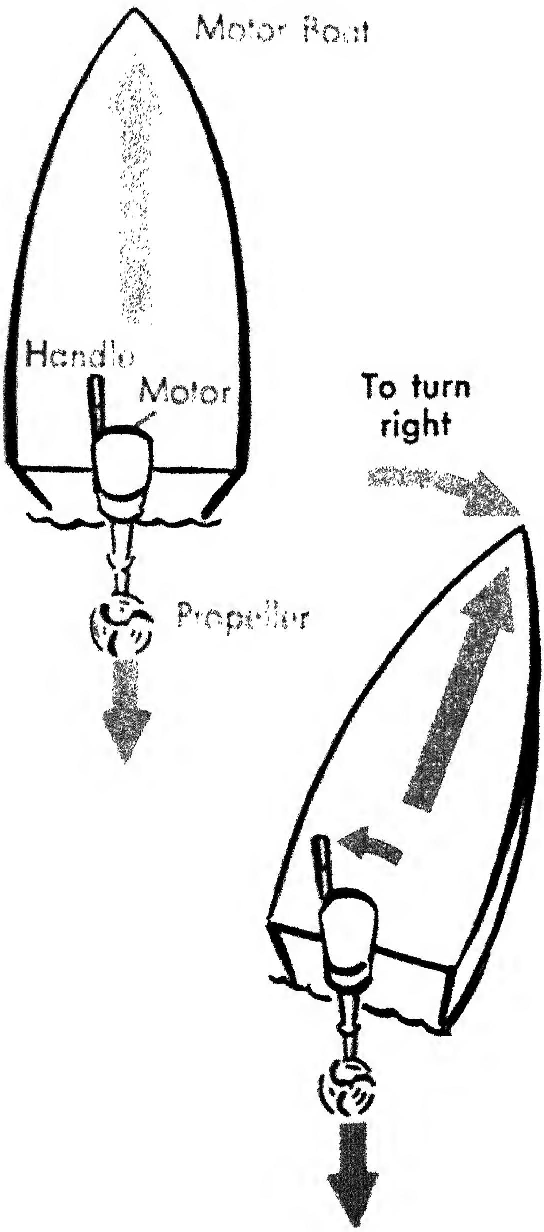
All ships must be steered, from the simple rowboat to the complex ocean liner. And they are all steered much the same way—using the force of water against a flat surface.

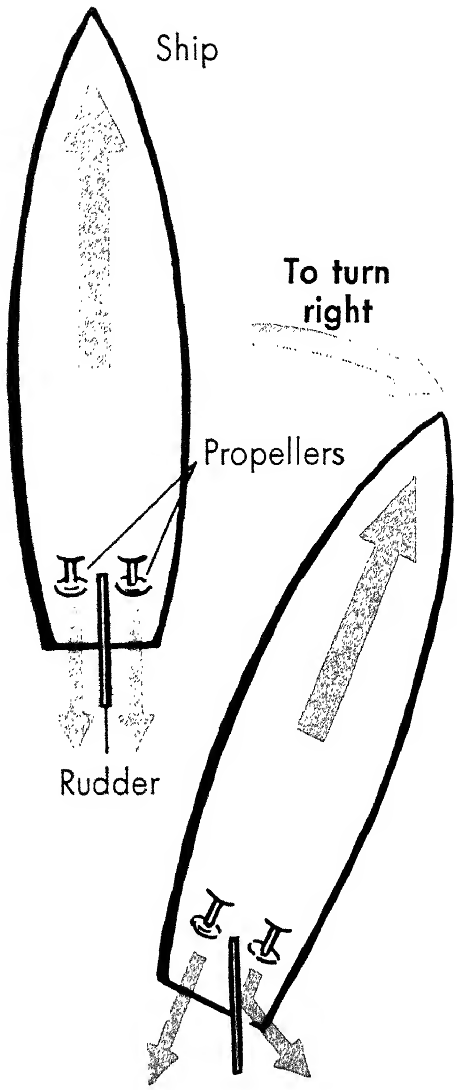
A person paddling a canoe usually sits in the back. To steer, he may hold the paddle in a way that permits water to push against it as the boat moves forward. The paddle thus acts as a brake for one side of the canoe. The other side is not held back, so the canoe begins to turn. If the paddle were kept in the water, the boat would make a complete circle around it.

Here's another method of steering a canoe. Normally you give the paddle a quarter turn away from the canoe at the end of each stroke. To turn, you paddle on one side with the broad blade of the paddle always pushing against the water. If you keep the broad blade of the paddle pushing against the water for each full stroke, the side on which you paddle goes faster than the other side. The canoe turns.

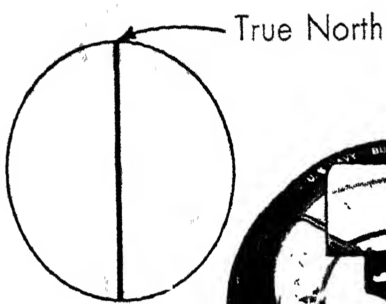
Steering a Powerboat

You steer a boat with an outboard engine by shifting the position of the engine itself. To steer to the right, you push the handle in front to the left. This movement makes the blades of the propeller change position as you see in the diagram. The propeller pushes the back of the boat to the left—thus pointing the front of the boat to the right.





Larger ships are usually steered by a huge, flat paddle at the rear of the ship. This flat paddle is called a rudder. When the rudder turns while the ship is moving, the water pushes against it more on one side than the other. The strong push of the water on one side of the rudder pushes the back of the ship to one side. Only a slight movement of the rudder is necessary to change the ship's direction.



U. S. Naval Observatory

***Above:* A magnetic compass**
***Right:* A navigator inspecting a gyrocompass**

Sperry Gyroscope Co.

Navigation

Navigation is the science of planning the best possible course of a ship or airplane in getting from one place to another. The route must be as short as possible. It must make allowances for ocean currents and winds. And, of course, a ship's navigator has no landmarks to help guide him. He sees only sky, ocean, sun, moon, stars, and clouds. How does the navigator do this difficult job?

One of the several aids that have been used to keep ships on course is the magnetic compass. This magnetic compass is much like those you have probably played with from time to time. A magnetic compass points in the general direction of the magnetic north pole, an area several hundred miles away from the true north pole. There are charts the navigator uses to tell exactly which direction the compass points any place on earth. If he knows which way is north, he can determine all other directions. Can you tell how?

A compass is a magnetic needle that is free to turn. Since the needle is in the earth's magnetic field, it points north from any location on earth.

Today many ships no longer use magnetic compasses. A better kind, called the gyrocompass, is used. It points to the true north pole rather than to the magnetic north pole.

A navigator using a sextant. With this instrument and his charts he can tell exactly where his ship is.

U. S. Naval Observatory

Determining a Ship's Position

Magnetic compasses and gyrocompasses tell the navigator his ship's direction. But he must also know the exact position of his ship at sea. With nothing but water all around, how can he determine his ship's position?

As you know, the earth turns completely around on its axis once every twenty-four hours. It also makes one trip around the sun every year. The stars move, too, but they are so very far away that they do not appear to move. We say that the stars are fixed but the earth is always moving. Since the earth is always moving, we see the stars from different positions at different times. The navigator has charts that tell him the exact position of the sun and stars each minute of every day in the year. He also has a clock that tells him the exact time at which he might be looking at stars. With an instrument called a sextant, he can find his position in relation to the sun and certain stars. Then, with the help of his charts, he can tell where he is.

Still another part of the navigator's job is to keep a record of the ship's voyage on a map. He keeps records of exactly where the ship travels, the ship's speed, and each change of direction. These records are necessary to keep the ship on course. These records are called the ship's log.

U. S. Coast Guard

Lightships like the *Ambrose* have helped keep many vessels out of danger.

Safe Travel

Thousands of ships sail the ocean every day. To keep travel as safe as possible, ship captains agree to keep their ships in certain paths. These paths are called shipping lanes. Ships traveling in different directions use different lanes.

There are also traffic rules for ships just as there are for cars. Here are a few:

1. In a fog, any ship, whether moving or standing still, must sound its fog horn often.
2. A ship must move slowly in a fog.
3. A sailboat has the right of way over a boat with engines.
4. When two ships are moving toward each other, each passes to the right of the other ship.
5. When two ships are crossing courses, the one on the right has the right of way.

These rules are just as useful on small lakes as they are on the ocean. If you plan to spend some time at the seashore or at a lake this summer, you will probably see more boats than ever. As you know, boating becomes a more popular sport every year.

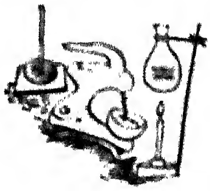
But as boating becomes more popular, there are also more boat accidents. Here are a few common types of accidents:

1. Tipping over because of people standing up.
2. Running into another boat at high speed.
3. Being upset by waves caused by the propeller of a larger boat moving at high speed.
4. Running into someone swimming.

Many of these accidents are caused by boats traveling at high speeds in crowded areas. What safety rules will help people avoid accidents of the type listed here?

The U.S. Coast Guard has the job of protecting small boats in certain areas. It strongly suggests that all small-boat passengers wear life jackets at all times. Although this suggestion should be followed by non-swimmers especially, it is a good rule for all small-boat operators and passengers. Life jackets have prevented many people from drowning after boat accidents.

Things to Do

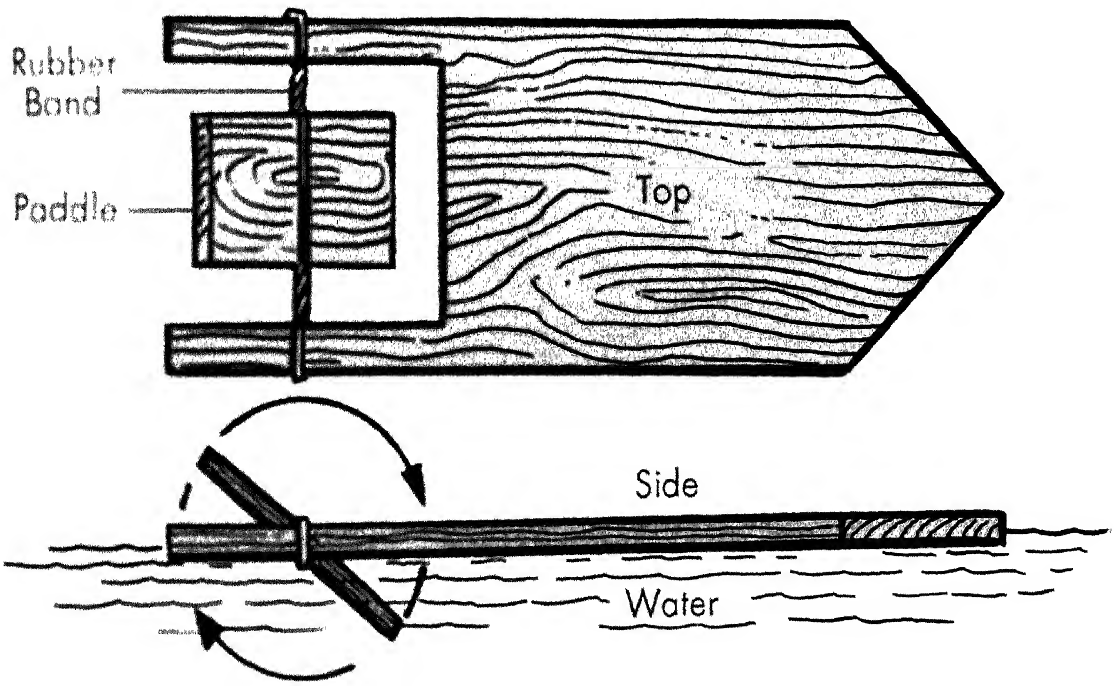


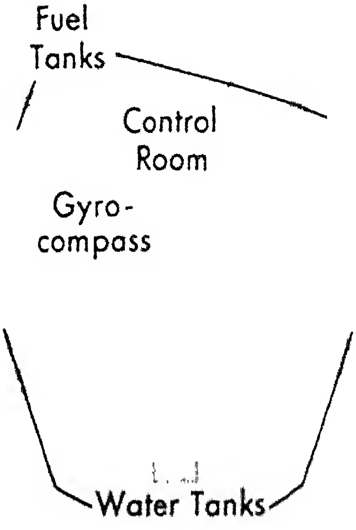
1. Write to the U.S. Coast Guard in Washington D.C., and ask for their pamphlets on safety in small boats.

2. Find out if there are special rules in your state about who can operate boats. Must you be a certain age to be a boat operator? Where do you find out?

3. Try running a small gyroscope to see how the wheel keeps its position no matter how you turn the outside.

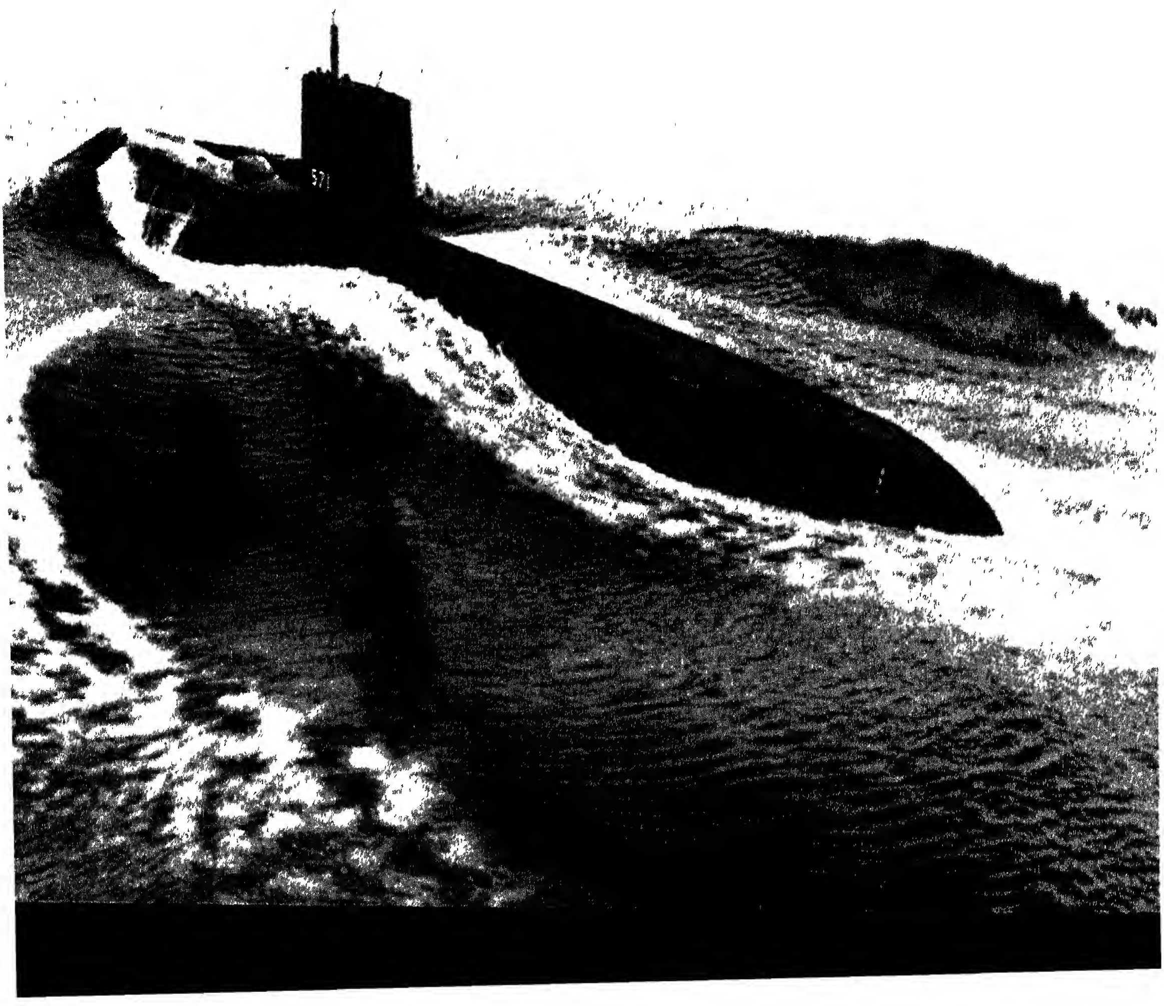
4. Here's a simple model paddle boat that you can make. Test it out with paddles of different shapes.

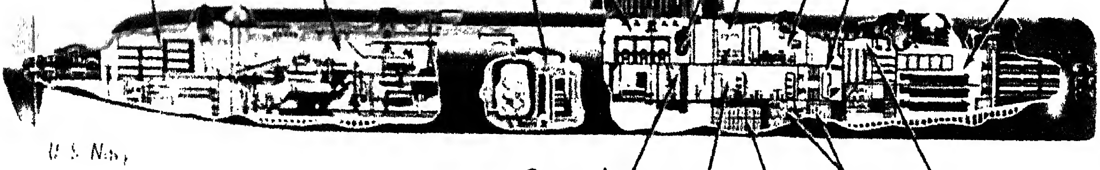




Right: A section of a submarine. *Below:* The *Nautilus,* the first submarine to be operated on atomic power

Electric Boat Division, General Dynamics Corporation





The plan of the *Nautilus*

SUBMARINES

The navy uses many kinds of ships. Battleships carry as many guns as possible. Aircraft carriers are really landing fields for warplanes. Torpedo boats are designed to move quickly and deliver torpedoes. Supply ships carry fuel, food, and spare parts for other ships. The navy also has spécial ships that lay mines—and others that cut mines away.

One of the most interesting navy ships is the submarine. Submarines are used for surprise attacks, mine laying, weather reporting, scouting, and for landing small groups of men for special kinds of work.

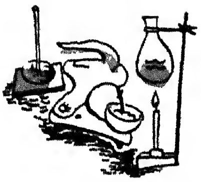
The submarine can operate either on, or beneath, the surface of the water. When it is on the surface, it floats just like any other ship. It moves by its propeller and powerful engines. It steers by a rudder.

To dive beneath the surface, the submarine must become heavier. It must weigh more than the water it displaces. To gain the extra weight, large tanks at the bottom and sides of the submarine are opened to admit sea water. The submarine starts to go down just like a floating jar that you slowly fill with water.

To come to the surface, pumps are turned on that remove water from the tanks. The weight of the submarine is controlled by regulating the amount of sea water in the tanks.

The submarine is steered beneath the surface by a rudder. And to help control diving and surfacing, the submarine has large metal plates sticking out of the sides. They work much like a rudder, but instead of moving right and left, they help the submarine move up and down smoothly.

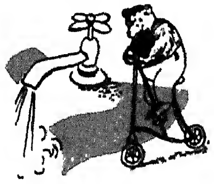
Things to Do



1. Make a chart of the constellations over your section of the country at different times of the year. Use a book about stars or an encyclopedia for help.

2. Make a poster to show as many different kinds of ships as you know about. Under each tell what it is used for.

Things to Talk About

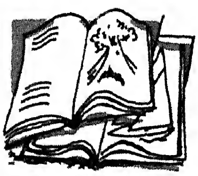


1. What is done to make nearby bodies of water in your community safe for swimming and boating? Are there lifeguards, special areas for swimming, boat rules?

2. For what safety reason do sailboats have the right of way over powerboats?

3. Why do flippers on your feet help you swim faster?

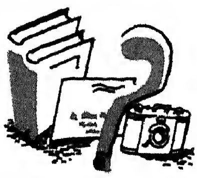
Things to Read About



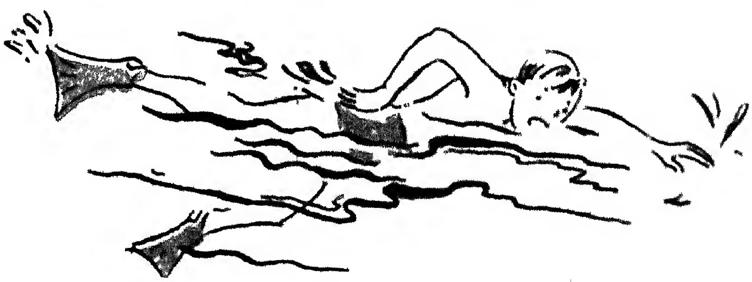
1. Make a report on a submarine used during the Revolutionary War. How was it powered? How did it dive and come to the surface?

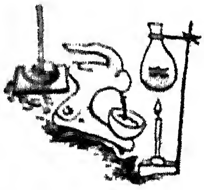
2. Find out how a gyrocompass works. Report to your class. If you can, use a toy gyroscope to explain the gyrocompass.

If You Want to Find Out More



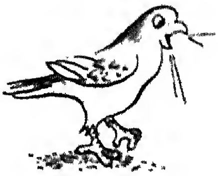
Make a report on the engine of an atomic submarine. How is it similar to an older type engine? How is it different?





Things You Can Find Out —and Things You Can Show

Glossary



A glossary is a small dictionary. This glossary contains the important words that you will find in this book. The meaning of each word and the page on which the word first appears is given after the word. In most cases, you will find only the scientific meaning that the word has in this book. In a large dictionary you can find other meanings for most of these words.

The words in this glossary have been respelled to help you pronounce them correctly. The marks on the words below show you how to pronounce the different letters.

ā as in māke	ē as in wē	ŏ as in tŏp	ū as in hūge
â as in shâre	ĕ as in lĕt	ô as in côrd	ŭ as in dŭst
ă as in hăt	ẽ as in ovẽr	o͞o as in to͞o	û as in fûr
ȧ as in ȧsk	ī as in kīte	o͝o as in co͝ok	th as in path
ä as in cär	ĭ as in tĭn	oi as in soil	**th** as in **they**
ȧ as in *ȧ*live	ō as in nō	ou is in loud	zh as in measure

adrenal glands (ăd rē′n*ȧ*l glăndz): Small glands above the small of your back. They make a chemical which helps the body work properly. In emergencies more of this chemical is poured into the blood, giving us extra energy. 65

allergic (ă lûr′jĭk): Very sensitive to certain things. When a person is allergic to a certain food, that food makes him ill. 19

anemia (*ȧ* nē′mĭ *ȧ*): An illness caused by not having enough red blood cells or enough of the chemical that makes these cells red. 27

anthracite (ăn′thr*ȧ* sīt): Hard coal. 264

anthrax (ăn′thrăks): A disease of cattle, sheep, and some other animals. It is caused by a certain kind of bacteria. 9

antiseptic (ăn tĭ sĕp′tĭk): A chemical that keeps germs from growing. 138

anxiety (ăng zī′ĕ tĭ): A strong feeling of worry or fear. 111

artesian well (är tē′zh*ȧ*n wĕl): A deep well that is drilled into the earth. Water from artesian wells may flow without being pumped. 238

astronomy (ăs-trŏn′ō mĭ): The scientific study of the planets, stars, and other bodies in space. 102

bacteria (băk tēr′ĭ *ȧ*): Tiny, one-celled plants that can be seen only with a microscope. Some cause disease. Many are helpful. 4

beriberi (bĕr ĭ bĕr′ĭ): A disease of the nervous system caused by a lack of thiamine, one of the B group vitamins. 28

bituminous (bĭ tū′mĭ nŭs): A kind of coal. It is softer than anthracite. 264

bulrush (bo͝ol′rŭsh): A grass-like plant that grows in moist places such as swamps. 203

carbohydrate (kär bō hī′drāt): A nutrient in food. Sugar and starch are carbohydrates. 18

carbon dioxide (kär′bŭn dī ŏk′sīd): A chemical made up of carbon and oxygen. Plants and animals breathe out carbon dioxide as a colorless gas. Dry ice is solid carbon dioxide. Carbon dioxide is often used in putting out fires. 80

cell (sĕl): The smallest part of a living thing. All living things are made up of one or more cells. Our bodies are made up of different kinds of cells. 24

cellulose (sĕl′ū lōs): A material found in the walls of plant cells. When we eat plant foods, we cannot digest the cellulose. 85

census (sĕn′sŭs): A counting of people to find out how many there are in a city, state, or country. A census can also be taken of animals or plants. 208

cerebellum (sĕr ĭ bĕl′ŭm): A part of the brain behind and below the cerebrum. It controls balance and makes the muscles work together properly. 56

cerebrum (sĕr′ĭ brŭm): The largest part of the brain. It is the part of the brain with which we think. 56

chemical (kĕm′ĭ kăl): A name given to many different substances. Everything in the world—food, air, and rocks is made up of different chemicals such as oxygen, carbon dioxide, iron, water, and so on. 78

chemical change: When one or more substances change into other substances. For example, when oxygen combines with food in the body, carbon dioxide and water are formed. This is a chemical change. 79

chemical element (ĕl′ĭ mĕnt): A substance which cannot be changed into a simpler one. Iron, copper, oxygen, and carbon are chemical elements. 78

chemistry (kĕm′ĭs tri): A scientific study of what substances contain and how substances may be changed. 78

comparison (kŏm păr′ĭ sŭn): A description of ways in which things are alike or different. 3

compound (kŏm′pound): A chemical substance made up of two or more chemical elements. Water is a compound made up of hydrogen and oxygen. 80

coördination (kō ôr dĭ nā′shŭn): The acting together of muscles or other parts of the body in such a way that the body works smoothly. 56

crystal (krĭs′tăl): A part of a solid substance, like a rock, which has a shape that can be clearly described. 92

decompose (dē kŏm pōz′): Change into simpler substances. When bacteria decompose the food on which they live, it is changed into carbon dioxide, water, and other chemicals. 227

deficiency disease (dĭ fĭsh′ĕn sĭ dĭ zēz′): A disease caused by a lack of a certain nutrient. Beriberi, for example, is a deficiency disease caused by a lack of thiamine, a vitamin of the B group. 31

diet (dī′ĕt): All the foods you eat. 16

displace (dĭs plās′): Take the place of something else. When a stone is put into water the stone takes the place of some of the water. Some water is displaced. 281

Eijkman, Christiaan, Dr. (īk′măn krĭs′tē än): A Dutch medical scientist, born in 1858; died in 1930. He discovered the cause of beriberi. 28

experiment (ĕks pĕr′ĭ mĕnt): A way of finding the answer to certain what, how, and why questions. You do an experiment whenever you change something to find out what happens, how it happens, or why it happens. 7

extinct (ĕks tĭngkt′): No longer to be found on earth. Some wildlife, such as the passenger pigeon, has become extinct. 194

fabric (făb′rĭk): Cloth that is woven or knit from fibers, such as silk, cotton, or nylon. 8

Faraday, Michael (făr′ȧ dā): An English scientist born in 1791; died in 1867. He made many important discoveries about magnetism and electricity. 301

fever (fē′vẽr): A body temperature higher than usual. 63

first aid (fûrst ād): The first things that are done to help an injured or sick person. 128

fluoride (flōō′*a* rīd): A chemical compound containing the chemical element, fluorine. It has been found that fluoride in drinking water helps prevent tooth decay. 242

flyway (flī′wā): A route which large flocks of birds take when they fly north and south with the change of the seasons. 209

fossil (fŏs′ĭl): The remains of a plant or animal that lived long ago. Fossils may be imprints in rock or preserved parts of the plant or animal. 96

germ (jûrm): A tiny plant or animal that causes disease. The germ that causes polio is called a virus. 34

gland (glănd): A part of the body that produces chemical substances which help the body work properly. 64

goiter (goi′tẽr): A disease in which the thyroid gland becomes larger than it should be. It may be caused by a lack of the chemical element, iodine. 27

ground water: The water that is in the ground. We dig wells to get ground water for our use. Ground water also drains into springs, ponds, and brooks. 233

habit (hăb′ĭt): Something that we have learned to do without thinking. 177

igneous (ĭg′nē ŭs): Formed or changed by great heat. Igneous rocks were formed from melted material in the earth. 93

incubator (ĭn′kū bā tẽr): A specially heated box in which eggs are hatched. 212

infected (ĭn fĕk′tĕd): Having been entered by a harmful bacteria. For example, a wound may become infected. 131

ingredient (ĭn grē′dĭ ĕnt): A part of a mixture, particularly a food mixture. For example, sugar, flour, and milk are ingredients of a cake. 89

intelligence (ĭn tĕl′ĭ jĕns): The ability to learn. 164

invertebrate (ĭn vûr′tē brāt): An animal with no backbone. Animals such as insects and worms have no backbones. They are examples of invertebrates. 167

irrigation (ĭr ĭ gā′shŭn): A way of getting needed water into the soil. Ditches, hoses, and pipes are used to irrigate the soil. 203

lava (lä′v*a*): Hot melted rock that comes out of a volcano. 93

lever (lē′vẽr): A simple machine, such as a teeter-totter, a nail puller, or a pair of pliers. Levers make it easier for you to do work by pushing, pulling, or lifting. 288

lignite (lĭg′nīt): A soft coal. Lignite is softer than anthracite or bituminous coal. 264

magma (măg′m*a*): Melted rock within the earth. When magma leaves the earth through a volcano, it is called lava. 93

magnetic field (măg nĕt′ĭk): The space around a magnet where things may be pulled or pushed by the magnet. 300

mammal (măm′*a*l): An animal whose young are born from the mother's body and are fed on milk from the mother. Mammals are warmblooded animals with backbones. They have hair or fur on their bodies. 168

marsh (märsh): Soft, wet land such as a swamp. Marshes are often formed on low, flat land around lakes and rivers. 203

metal (mĕt′l): A chemical element that has certain characteristics or properties. Some metals are iron, silver, and gold. 256

metamorphic (mĕt *a* môr′fĭk): Changing. Rocks in the earth that have been changed by heat and pressure are called metamorphic rocks. 96

mineral (mĭn′ẽr *a*l): Any non-living thing that is found naturally on earth. 18, 92

motor nerve (mō′tẽr nûrv): A nerve that carries action messages from the brain or spinal cord to another part of the body. 55

nerve: A stringlike bundle of tiny living threads in our bodies along which "messages" to and from the brain and spinal cord can travel. 51

nervous system (nûr′vŭs sĭs′tĕm): The brain, spinal cord, and nerves which go to all parts of the body. 50

niacin (nī′*a* sĭn): A vitamin of the B group. A lack of niacin causes pellagra. 29

nutrient (nū′trĭ ĕnt): A substance which the body needs for growth, repair, and energy. Nutrients are obtained from food. 16

ore (ōr): Rock from which metal can be obtained. 263

paralysis (p*a* răl′ĭ sĭs): Loss of the ability to move certain parts of the body. 69

parathyroid glands (păr *a* thī′roid): Small glands located in or on the thyroid gland. They produce a substance which controls the use of calcium by the body. 65

Pasteur, Louis (păs tĕr′): A French chemist; born in 1822; died in 1895. He made many important discoveries about diseases caused by germs. He discovered that animals could be protected from certain diseases by "shots." 9

pasteurized (păs′tĕr īzd): Heated to a temperature high enough to kill harmful germs. When milk is pasteurized, it is heated to about 145° F. for 30 minutes. 35

peat (pēt): A substance formed from plants when they decompose in water. Peat can be dried and used for fuel. 264

personality (pûr sŭ năl′ĭ tĭ): All of the things about you that make you a certain person—what you are and the way you behave. 106

physical change (fĭz′ĭ k*a*l): A change that does not result in a different substance. When ice melts it changes, but it is still water. When water evaporates it changes, but it is still water. These are physical changes. 79

piston (pĭs′tŭn): The part of an engine that fits tightly into a round tube and is pushed when gases expand (spread out) in the engine. In a steam engine, it is the hot steam that pushes the piston. Exploding gasoline pushes the pistons in an automobile engine. 299

pituitary (pĭ tū′ĭ tĕr ĭ): A gland located beneath the brain. It produces a chemical that controls the rate of growth. 65

polio (pōl′ĭ ō): A disease caused by a virus. The virus may kill nerves and cause paralysis. Another name for this disease is infantile paralysis. 69

polluted (pŭ lūt′ĕd): Mixed with impurities or disease germs. Water becomes polluted when wastes are dumped into it. 196

pondweed (pŏnd′wēd): Plants that grow around the edges of lakes or ponds. 204

propeller (prō pĕl′ĕr): A set of blades attached to a shaft or rod. When the shaft is made to turn, the propeller turns. When it turns in water or air the blades will push or pull. 292

property (prŏp′ĕr tĭ): A characteristic or ability of a substance. One property of copper is that it will conduct electricity. 256

protein (prō′tē ĭn): A nutrient that is necessary for growth and repair of the body. 18

psychologist (sī kŏl′ŭ jĭst): A scientist who studies the behavior of people. 106

reflex (rē′flĕks): An automatic act that you do not have to learn. A sneeze is an example of a reflex. 60

refuge (rĕf′ūj): A shelter or protection from danger. A wildlife refuge is a place where no one is allowed to hunt animals. 207

reservoir (rĕz′ĕr vwôr): A place where water is collected and kept for use. 236

riboflavin (rī bō flā′vĭn): One of the vitamins of the B group. It is important for growth and healthy nerves. 29

rock (rŏk): Solid stony material found in the earth. Pieces of rock are sometimes called stones or pebbles. 92

rust (rŭst): The reddish coating that forms on iron objects. Rust is a compound made up of iron and oxygen. 79

Salk, Jonas, Dr. (sôlk): An American medical scientist, born in New York City in 1914. He made the first vaccine to be used in protecting people from polio. 69

sanctuary (săngk′tū ĕr ĭ): A shelter or protection from danger. A wildlife sanctuary is usually set up especially for one kind of animal. In a sanctuary no one is allowed to hunt or harm the animals. 207

sediment (sĕd′ĭ mĕnt): Material which is carried in water and which settles to the bottom. 94

sedimentary (sĕd ĭ mĕn′tȧ rĭ): Formed or made from sediment. Sedimentary rocks were formed from material that settled to the bottom of lakes and seas thousands of years ago. 94

sensory nerve (sĕn′sŭ rĭ): A nerve that carries messages to the brain. Sensory nerves make it possible for you to see, hear, smell, taste, and feel things. 55

septic tank (sĕp′tĭk tăngk): A large container into which waste materials from homes, schools or factories flow. Most septic tanks are set in holes dug deeply into the ground. In the tank, the wastes are decomposed. The remaining liquid drains off into the ground. 246

soil erosion (ĕ rō′zhŭn): The wearing away of soil. 229

steam turbine (tûr′bĭn): An engine in which steam turns a wheel by hitting little cups or vanes on the wheel. 295

sterile (stĕr′ĭl): Containing no germs or any other living thing. A bandage is sterile when all germs on it have been killed. 132

still (stĭl): A container in which vapors or gases are cooled and changed to liquid. In a water still, water vapor or steam is cooled and changed to liquid water. This is called distilled water. 234

surface water (sûr′fĭs): Water that is on top of the ground. The water in ponds, streams, and lakes is surface water. 232

sweat glands (swĕt): Tiny coiled tubes that collect water, salt, and some other wastes from the blood and let them out as sweat on the surface of the skin. Sweat glands help to keep the body cool. 61

thiamine (thī′ȧ mĭn): A vitamin of the B group. It prevents beriberi. 29

thyroid (thī′roid): A gland located in the neck. It produces a chemical that is needed for you to get the proper amount of energy from food and to grow properly. 65

vaccine (văk′sēn): Material that contains dead or weakened germs. It is put into your body to keep you from getting the disease caused by the germs. Polio "shots" contain polio vaccine. 69

vertebrate (vûr′tē brāt): An animal with a backbone. 167

vibrate (vī′brāt): To move back and forth. When things vibrate fast enough they make sound waves you can hear. When you speak, your vocal cords vibrate. 124

virus (vī′rŭs): A germ so small that it cannot be seen with an ordinary microscope. Polio is caused by a virus. 4

vitamin (vī′tȧ mĭn): A chemical substance necessary for health and found in small amounts in foods. 18

vocal cords (vō′kȧl): Thin bands stretched across your voice box. You speak by pushing air over the cords and making them vibrate. 124

Waksman, Selman, Dr. (wăks′mȧn): An American scientist, born in Russia in 1888. He discovered a number of chemicals that can be obtained from tiny plants and used in treating diseases. 4

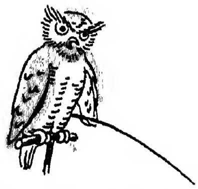
waterfowl (wô′tĕr foul): Swimming birds such as ducks and geese. 194

watershed (wô′tĕr shĕd): A large area of land from which water runs toward a stream, river, or reservoir. 236

water table: The highest level of ground water. 238

wildlife: Any living thing that grows without man's help. The word is generally used to mean wild animals such as birds, deer, bear, fish, rabbits, and so on. 182

wound (wo͞ond): An injury in which the skin is cut or punctured. 130



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